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Marv Cherry
Sales Representative

HEWLETT PACKARD
NEELY
Sales Region

9606 AERO DRIVE
SAN DIEGO, CA 92123
(619) 279-3200

Microwave & RF Designer's Catalog 1987-1988



HEWLETT PACKARD

Microwave & RF Designer's Catalog 1987-1988

Intensive research and development of advanced manufacturing techniques have enabled Hewlett-Packard to become a high volume supplier of quality, competitively priced RF/microwave diodes, transitors, and integrated products.

In addition to our broad product line, Hewlett-Packard also offers the following services: applications support, special testing for customer requirements and a one year guarantee on all of our products. Each product accepted for commercial sale has been tested for reliability during the development phase and is subject to quality assurance procedures throughout the manufacturing process.

This package of products and services has enabled Hewlett-Packard to become a recognized leader in the semiconductor industry.

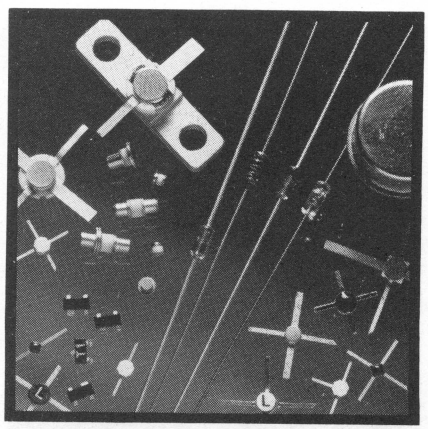
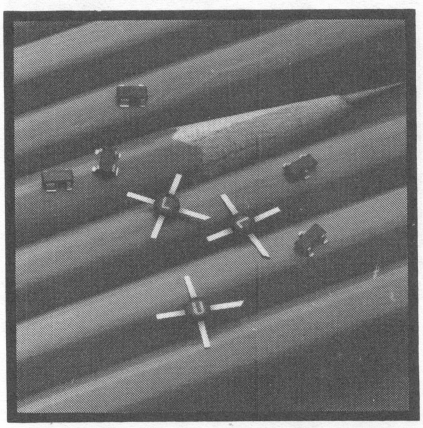


Table of Contents

Ordering Information vii
Alphanumeric Index 1-1
High Reliability 2-1
Quality Assurance 3-1
Silicon Bipolar Transistors 4-1
Schottky Barrier Diodes 5-1
Switching Diodes 6-1
PIN Diodes 7-1
Step Recovery Diodes 8-1
Coaxial and Waveguide Components 9-1
Amplifiers and High Speed Circuits 10-1
Switches, Switch Drivers and Modulators 11-1
Mixers and Detectors 12-1
Comb Generators 13-1
Broadband DC Return 14-1
Package Outlines 14-8
Stocking Distributors 14-12
Sales and Service Offices 14-12



NEW

Identifies newly introduced products or capabilities. New products are also indicated by boldface listings in the Numeric Index.

AVAILABLE

Identifies products soon to be released. See page v for further information.

Products produced by HP Stanford Park Division are indicated by italic type in the Numeric Index. See page 8-1 for further information.

A Brief Sketch

Hewlett-Packard is one of the world's leading designers and manufacturers of electronic, medical, analytical, and computing instruments and systems, diodes, transistors, integrated products, and optoelectronic products. Since its founding in Palo Alto, California, in 1939, HP has done its best to offer only products that represent significant technological advancements.

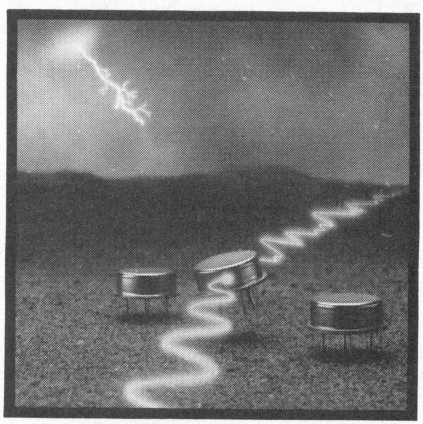
To maintain its leadership in instrument and component technology, Hewlett-Packard invests heavily in new product development. Research and development expenditures traditionally average about 10 percent of sales revenue. This level of commitment enables the company to employ the latest technologies in developing innovative products that can be reliably produced, delivered, and supported on a continuing basis.

HP produces more than 3,500 products at our domestic divisions in California, Colorado, Washington, Oregon, Idaho, Massachusetts, New Jersey and Pennsylvania and at overseas plants located in the German Federal Republic, England, Scotland, France, Japan, Singapore, Malaysia, Brazil, Mexico and Puerto Rico.

However, for the customer, Hewlett-Packard is no further away than the nearest telephone. Hewlett-Packard currently has sales and service offices located around the world (Page 14-12).

These field offices are staffed by trained engineers, each of whom has the primary responsibility of providing technical assistance and data to customers.

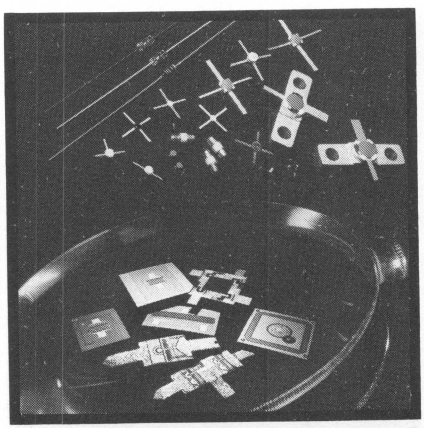
A vast communications network has been established to link each field office with the factories and with corporate offices. No matter what the product or the request, a customer can be accommodated by a single contact with the company.



Microwave and RF Semiconductors

Hewlett-Packard's manufacturing plant located in San Jose, California, houses such modern equipment as projection mask aligning and automation handling systems. Ion implantation, new evaporation and wet processing systems, and scanning electron microscopy provide the basis for quality and dependability for the entire product line.

When quality represents a competitive edge, or when reputation and dependability of your products is on the line, you can count on Hewlett-Packard RF and microwave semiconductor devices for excellent product consistency.



About This Catalog

This Microwave and RF Designer's Catalog contains detailed and up-to-date specifications of our complete line of RF, microwave, and integrated products. Also included in the catalog is information on several products which will be introduced in the future, but which deserve special mention now. These products are indicated with an "Available . . ." banner across the first page of the data sheet. For the latest information on these devices, please contact your local Hewlett-Packard Components sales office.

This catalog is divided into eleven product sections. At the end of each section, a complete index of application notes and bulletins pertaining to the use of those products is included.

Also included in each section where possible are the equivalent circuits of each product. These will be of use in computer-aided design circuits.

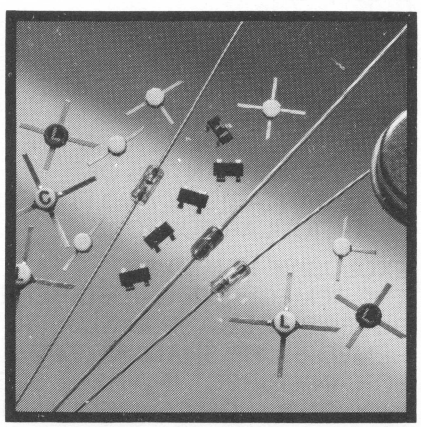
On each of the product data sheets, the "Absolute Maximum Ratings" table indicates the limits of the device. Operation in excess of any of these conditions may result in permanent damage to the device. Information concerning the MTTF design goals for the devices is included in the reliability pages at the end of each product section.

How To Use This Catalog

Three methods are incorporated for locating components:

- A table of contents that allows you to locate devices by their general description.
- An alphanumeric index that lists all devices by part number plus generic chip part numbers.
- Selection guides at the beginning of each product section generally grouping products by major specification, frequency, etc.

Although product information and illustrations in this catalog were current at the time it was approved for printing, Hewlett-Packard, in a continuing effort to offer excellent products at a fair value, reserves the right to change specifications, designs, and models without notice.



Ordering Information, After Sales Services

How To Order
All Hewlett-Packard components may be ordered through any of the Sales and Service offices listed on page 14-12. In addition, for immediate off-the-shelf delivery of Hewlett-Packard RF and microwave semiconductor devices, contact any of the worldwide stocking distributors and representatives listed on page 14-8.

Warranty
As an expression of confidence in our products to continue meeting the high standards of reliability and performance that customers have come to expect, Hewlett-Packard RF and microwave semiconductor products carry the following warranty.

HP's Components are warranted against defects in material and workmanship for a period of one year from the date of shipment. HP will repair or, at its option, replace components that prove to be defective in material or workmanship under proper use during the warranty period. This warranty extends only to HP customers.

NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES
THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT TORT OR ANY OTHER LEGAL THEORY.

Certification
Some customers are especially interested in the test and quality assurance programs that HP applies to its products. These Hewlett-Packard programs are documented in a Certificate of Conformance which is available upon request at the time of purchase. This certification states:

We certify that the Microwave Semiconductor Division devices were duly tested and inspected prior to shipment and that they met all of the published specifications for these devices.

Hewlett-Packard's calibration measurements are traceable to the National Bureau of Standards to the extent allowed by the Bureau's calibration facilities.

The Hewlett-Packard Quality Program satisfies the requirements of MIL-Q-9858A, MIL-I-45208A, MIL-S-19500, MIL-STD-45662A, and NASA NHB 5300.4 (1.C.).

Service
We firmly believe that our obligation to you as a customer goes much beyond just the delivery of your new HP product. This philosophy is implemented by Hewlett-Packard in two basic ways: (1) by designing and building excellent products with good serviceability, and (2) by backing up those products with a customer service program which can respond to your needs with speed and completeness.

The HP customer service program is one of the most important facets of our worldwide operations, providing a local service capability in many of our field offices (listed on page 14-12). Indeed, this customer service program is one of the major factors in Hewlett-Packard's reputation for integrity and responsibility towards its customers.

Alphanumeric Index

MODEL NO.	DESCRIPTION	GENERIC CHIP	PAGE NO.
HAMP-1001	10-1500 MHz TO-8 Cascadable Amplifier		9-5
HAMP-1001TXV	Hi-Rel HAMP-1001		9-5
HAMP-1002	10-1500 MHz TO-8 Cascadable Amplifier		9-5
HAMP-1002TXV	Hi-Rel HAMP-1002		9-5
HAMP-1003	10-1500 MHz TO-8 Cascadable Amplifier		9-5
HAMP-1003TXV	Hi-Rel HAMP-1003		9-5
HAMP-1004	10-1500 MHz TO-8 Cascadable Amplifier		9-5
HAMP-1004TXV	Hi-Rel HAMP-1004		9-5
HAMP-4001	Variable Gain Wideband Amplifier		9-18
HAMP-4001TXV	Hi-Rel HAMP-4001		9-18
HAMP-4002	Variable Gain Wideband Amplifier		9-18
HAMP-4002TXV	Hi-Rel HAMP-4002		9-18
HMXR-5001	Double Balanced Mixer 2-12.4 GHz		11-2
HPND-0001*	Small Signal RF PIN Diode Chip		6-10
HPND-0002*	Small Signal RF PIN Diode Chip		6-10
HPND-0003*	Small Signal RF PIN Diode Chip		6-10
HPND-4001	Beam Lead PIN Diode		6-14
HPND-4001TXV	Hi-Rel HPND-4001		6-49
HPND-4005	Beam Lead PIN Diode		6-16
HPND-4005TXV	Hi-Rel HPND-4005		6-51
HPND-4018*	Fast Switching Beam Lead PIN Diode		6-18
HPND-4028	Fast Switching Beam Lead PIN Diode		6-20
HPND-4028TXV	Hi-Rel HPND-4028		6-72
HPND-4038	Fast Switching Beam Lead PIN Diode		6-20
HPND-4038TXV	Hi-Rel HPND-4038		6-72
HPND-4050	Beam Lead PIN Diode		6-14
HPND-4050TXV	Hi-Rel HPND-4050		6-49
HPND-4165	RF PIN Diode	5082-0012	6-29
HPND-4166	RF PIN Diode	5082-0012	6-29
HSCH-0812	Hi-Rel Zero Bias Schottky (HSCH-3486)		4-103
HSCH-0813	Matched Pair HSCH-0814 (5082-2401)		4-87
HSCH-0814	Hi-Rel Schottky Barrier Diode (5082-2400)		4-87
HSCH-0815	Matched Pair HSCH-0816 (5082-2306)		4-87
HSCH-0816	Hi-Rel Schottky Barrier Diode (5082-2301)		4-87
HSCH-1001	General Purpose Schottky Diode (1N6263)		4-47/5-6

BOLD..... New Products
ITALICS.... Stanford Park Products
*..... "Available . . ." soon
†..... Consult factory

MODEL NO.	DESCRIPTION	GENERIC CHIP	PAGE NO.
HSCH-1111	Hi-Rel Schottky Chip		4-79
HSCH-3206	Zero Bias Detector Schottky Diode	5082-0013	4-70
HSCH-3207	Zero Bias Detector Schottky Diode	5082-0013	4-70
HSCH-3486	Zero Bias Detector Schottky Diode		4-70
HSCH-5310	Medium V_F Schottky Beam Lead		4-18
HSCH-5311	Batch Matched HSCH-5310		4-18
HSCH-5312	Medium V_F Schottky Beam Lead		4-18
HSCH-5313	Batch Matched HSCH-5312		4-18
HSCH-5314	Ku Band Medium V_F Schottky Beam Lead		4-18
HSCH-5315	Batch Matched HSCH-5314		4-18
HSCH-5316	Medium V_F Schottky Beam Lead		4-18
HSCH-5317	Batch Matched HSCH-5316		4-18
HSCH-5318	X-Band Medium V_F Schottky Beam Lead		4-18
HSCH-5319	Batch Matched HSCH-5318		4-18
HSCH-5320	Medium Barrier Beam Lead Schottky Diode		4-18
HSCH-5321	Batch Matched HSCH-5320		4-18
HSCH-5330	Low V_F Schottky Beam Lead		4-18
HSCH-5331	Batch Matched HSCH-5330		4-18
HSCH-5332	Low V_F Schottky Beam Lead		4-18
HSCH-5333	Batch Matched HSCH-5332		4-18
HSCH-5334	Ku Band Low V_F Schottky Beam Lead		4-18
HSCH-5335	Batch Matched HSCH-5334		4-18
HSCH-5336	Low V_F Schottky Beam Lead		4-18
HSCH-5337	Batch Matched HSCH-5336		4-18
HSCH-5338	X-Band Low V_F Schottky Beam Lead		4-18
HSCH-5339	Batch Matched HSCH-5338		4-18
HSCH-5340	Low Barrier Beam Lead Schottky Diode		4-18
HSCH-5341	Batch Matched HSCH-5340		4-18
HSCH-5510	Ku Band Medium V_F Schottky Beam Lead Pair		4-25
HSCH-5511	Medium V_F Schottky Beam Lead Pair		4-25
HSCH-5512	Medium Barrier Beam Lead Schottky Diode		4-25
HSCH-5514	Medium Barrier Beam Lead Schottky Diode		4-25
HSCH-5516	Medium Barrier Beam Lead Schottky Diode		4-25
HSCH-5518	Medium Barrier Beam Lead Schottky Diode		4-25
HSCH-5520	Medium Barrier Beam Lead Schottky Diode		4-25
HSCH-5530	Ku Band Low V_F Schottky Beam Lead Pair		4-25
HSCH-5531	Low V_F Schottky Beam Lead Pair		4-25
HSCH-5532	Low Barrier Beam Lead Schottky Diode		4-25
HSCH-5534	Low Barrier Beam Lead Schottky Diode		4-25
HSCH-5536	Low Barrier Beam Lead Schottky Diode		4-25
HSCH-5538	Low Barrier Beam Lead Schottky Diode		4-25
HSCH-5540	Low Barrier Beam Lead Schottky Diode		4-25
HSCH-5810	Medium Barrier Beam Lead Schottky Diode		4-31
HSCH-5812	Medium Barrier Beam Lead Schottky Diode		4-31
HSCH-5816	Medium Barrier Beam Lead Schottky Diode		4-31
HSCH-5830	Low Barrier Beam Lead Schottky Diode		4-31
HSCH-5832	Low Barrier Beam Lead Schottky Diode		4-31
HSCH-5836	Low Barrier Beam Lead Schottky Diode		4-31
HSCH-5918*	Beam Lead Schottky Diode Bridge Quad		4-34
HSCH-5938*	Beam Lead Schottky Diode Bridge Quad		4-34

MODEL NO.	DESCRIPTION	GENERIC CHIP	PAGE NO.
HSCH-5958*	Beam Lead Schottky Diode Bridge Quad		4-34
HSCH-6310	Medium Barrier Hermetic Schottky Diode		4-51
HSCH-6312	Medium Barrier Hermetic Schottky Diode		4-51
HSCH-6330	Low Barrier Hermetic Schottky Diode		4-51
HSCH-6332	Low Barrier Hermetic Schottky Diode		4-51
HSCH-6510	Medium Barrier Hermetic Schottky Diode		4-51
HSCH-6512	Medium Barrier Hermetic Schottky Diode		4-51
HSCH-6530	Low Barrier Hermetic Schottky Diode		4-51
HSCH-6532	Low Barrier Hermetic Schottky Diode		4-51
HSCH-6810	Medium Barrier Hermetic Schottky Diode		4-51
HSCH-6812	Medium Barrier Hermetic Schottky Diode		4-51
HSCH-6830	Low Barrier Hermetic Schottky Diode		4-51
HSCH-6832	Low Barrier Hermetic Schottky Diode		4-51
HSMP-3800*	Surface Mount PIN Diode	HPND-0001	6-25
HSMP-3801*	Surface Mount PIN Diode	HPND-0001	6-25
HSMP-3810*	Surface Mount PIN Diode	HPND-0002	6-25
HSMP-3811*	Surface Mount PIN Diode	HPND-0002	6-25
HSMP-3830*	Surface Mount PIN Diode	5082-0012	6-25
HSMP-3831*	Surface Mount PIN Diode	5082-0012	6-25
HSMS-0001	Offset Junction Schottky Barrier Chip		4-15
HSMS-0002	Offset Junction Schottky Barrier Chip		4-15
HSMS-0003	Offset Junction Schottky Barrier Chip		4-15
HSMS-0011	Batch Matched HSMS-0001		4-15
HSMS-0012	Batch Matched HSMS-0002		4-15
HSMS-0013	Batch Matched HSMS-0003		4-15
HSMS-2800	Surface Mount Schottky Barrier Diode	HSMS-0001	4-37
HSMS-2801	Surface Mount Schottky Barrier Diode	HSMS-0001	4-37
HSMS-2802	Surface Mount Schottky Barrier Diode	HSMS-0001	4-37
HSMS-2803	Surface Mount Schottky Barrier Diode	HSMS-0001	4-37
HSMS-2804	Surface Mount Schottky Barrier Diode	HSMS-0001	4-37
HSMS-2805*	Surface Mount Schottky Barrier Diode	HSMS-0001	4-42
HSMS-2808*	Surface Mount Schottky Barrier Diode	HSMS-0001	4-42
HSMS-2810	Surface Mount Schottky Barrier Diode	HSMS-0002	4-37
HSMS-2811	Surface Mount Schottky Barrier Diode	HSMS-0002	4-37
HSMS-2812	Surface Mount Schottky Barrier Diode	HSMS-0002	4-37
HSMS-2813	Surface Mount Schottky Barrier Diode	HSMS-0002	4-37
HSMS-2814	Surface Mount Schottky Barrier Diode	HSMS-0002	4-37
HSMS-2818*	Surface Mount Schottky Barrier Diode	HSMS-0002	4-42
HSMS-2820	Surface Mount Schottky Barrier Diode	HSMS-0003	4-37
HSMS-2821	Surface Mount Schottky Barrier Diode	HSMS-0003	4-37
HSMS-2822	Surface Mount Schottky Barrier Diode	HSMS-0003	4-37
HSMS-2823	Surface Mount Schottky Barrier Diode	HSMS-0003	4-37
HSMS-2824	Surface Mount Schottky Barrier Diode	HSMS-0003	4-37
HSMS-2825*	Surface Mount Schottky Barrier Diode	HSMS-0003	4-42
HSMS-2828*	Surface Mount Schottky Barrier Diode	HSMS-0003	4-42
HSMS-2840	Low Cost Surface Mount Schottky Diode		4-37/5-2
HSMS-2841	Low Cost Surface Mount Schottky Diode		4-37/5-2
HSMX-3131	Surface Mount General Purpose Transistor	HXTR-3001	3-46
HSMX-3151*	Surface Mount General Purpose Transistor	HXTR-3001	3-50
HSMX-3635	Surface Mount General Purpose Transistor	HXTR-7011	3-58

MODEL NO.	DESCRIPTION	GENERIC CHIP	PAGE NO.
HSMX-3655*	Surface Mount General Purpose Transistor	HXTR-7011	3-65
HXTR-2001	General Purpose Transistor Chip		3-12
HXTR-2101	General Purpose Transistor (2N6679)	HXTR-2001	3-31
HXTR-2101TXV	Hi-Rel HXTR-2101	HXTR-2001	3-112
HXTR-2102	General Purpose Transistor	HXTR-2001	3-33
HXTR-2102TXV	Hi-Rel HXTR-2102	HXTR-2001	3-112
HXTR-3001	General Purpose Transistor Chip		3-14
HXTR-3002	Linear Power Transistor Chip		3-16
HXTR-3101	Low Cost General Purpose Transistor	HXTR-3001	3-35
HXTR-3101TXV	Hi-Rel HXTR-3101	HXTR-3001	3-116
HXTR-3102	Low Cost General Purpose Trans Linear Power	HXTR-3002	3-37
HXTR-3102TXV	Hi-Rel HXTR-3102	HXTR-3002	3-120
HXTR-3103	General Purpose Transistor (2N6838)	HXTR-3001	3-39
HXTR-3103TXV	Hi-Rel HXTR-3103	HXTR-3001	3-116
HXTR-3104	Linear Power Transistor (2N6839)	HXTR-3002	3-42
HXTR-3104TXV	Hi-Rel HXTR-3104	HXTR-3002	3-120
HXTR-3121	Low Cost General Purpose Transistor	HXTR-3001	3-44
HXTR-3615	Low Cost Low Noise Transistor	HXTR-7011	3-52
HXTR-3615TXV	Hi-Rel HXTR-3615	HXTR-7011	3-124
HXTR-3625	Low Cost General Purpose Transistor	HXTR-7011	3-55
HXTR-3645	Low Cost High Performance Transistor	HXTR-7011	3-62
HXTR-3645TXV	Hi-Rel HXTR-3645	HXTR-7011	3-124
HXTR-3675	Low Cost High Performance Transistor	HXTR-7011	3-67
HXTR-3675TXV	Hi-Rel HXTR-3675	HXTR-7011	3-124
HXTR-4101	General Purpose Oscillator Transistor	HXTR-2001	3-70
HXTR-4101TXV	Hi-Rel HXTR-4101	HXTR-2001	3-128
HXTR-4103	High Output Power Oscillator Transistor	HXTR-5002	3-72
HXTR-4103TXV	Hi-Rel HXTR-4103	HXTR-5002	3-128
HXTR-4104	Low Cost Oscillator Transistor	HXTR-3002	3-74
HXTR-4104TXV	Hi-Rel HXTR-4104	HXTR-3002	3-128
HXTR-4105	Low Cost Oscillator Transistor	HXTR-7011	3-76
HXTR-4105TXV	Hi-Rel HXTR-4105	HXTR-7011	3-128
HXTR-5001	Linear Power Transistor Chip		3-18
HXTR-5002	Linear Power Transistor Chip		3-21
HXTR-5101	Linear Power Transistor (2N6701)	HXTR-5001	3-76
HXTR-5101TXV	Hi-Rel HXTR-5101	HXTR-5001	3-134
HXTR-5102	Linear Power Transistor	HXTR-5002	3-81
HXTR-5102TXV	Hi-Rel HXTR-5102	HXTR-5002	3-134
HXTR-5103	Linear Power Transistor (2N6741)	HXTR-5001	3-84
HXTR-5103TXV	Hi-REl HXTR-5103	HXTR-5001	3-134
HXTR-5104	Linear Power Transistor	HXTR-5002	3-87
HXTR-5104TXV	Hi-Rel HXTR-5104	HXTR-5002	3-134
HXTR-6001	Low Noise Transistor Chip		3-24
HXTR-6101	Low Noise Transistor (2N6617)	HXTR-6001	3-90
HXTR-6101TXV	Hi-Rel HXTR-6101	HXTR-6001	3-139
HXTR-6102	Low Noise Transistor (2N6742)	HXTR-6001	3-93
HXTR-6102TXV	Hi-Rel HXTR-6102	HXTR-6001	3-139
HXTR-6103	Low Noise Transistor (2N6618)	HXTR-6001	3-96
HXTR-6103TXV	Hi-Rel HXTR-6103	HXTR-6001	3-139
HXTR-6104	Low Noise Transistor (2N6743)	HXTR-6001	3-99

MODEL NO.	DESCRIPTION	GENERIC CHIP	PAGE NO.
HXTR-6104TXV	Hi-Rel HXTR-6104	HXTR-6001	3-139
HXTR-6105	General Purpose Transistor	HXTR-2001	3-102
HXTR-6105TXV	Hi-Rel HXTR-6105	HXTR-2001	3-112
HXTR-6106	General Purpose Transistor	HXTR-2001	3-105
HXTR-6106TXV	Hi-Rel HXTR-6106	HXTR-2001	3-112
HXTR-7011	Low Noise Transistor Chip		3-26
HXTR-7111	Low Noise High Performance Transistor	HXTR-7011	3-108
HXTR-7111TXV	Hi-Rel HXTR-7111	HXTR-7011	3-143
JAN 1N5711	MIL-S-19500/444 Schottky Diode	5082-0024	4-89
JAN 1N5712	MIL-S-19500/445 Schottky Diode	5082-0087	4-93
JAN 1N5719	MIL-S-19500/443 PIN Diode	5082-0012	6-53
JANTX 1N5711	MIL-S-19500/444 Schottky Diode	5082-0024	4-89
JANTX 1N5712	MIL-S-19500/445 Schottky Diode	5082-0087	4-93
JANTX 1N5719	MIL-S-19500/443 PIN Diode	5082-0012	6-53
JANTXV 1N5711	MIL-S-19500/444 Schottky Diode	5082-0024	4-89
JANTXV 1N5712	MIL-S-19500/445 Schottky Diode	5082-0087	4-93
TXVB-2810	Hi-Rel 5082-2810		4-97
TXVB-2811	Hi-Rel 5082-2811		4-97
TXVB-2835	Hi-Rel 5082-2835		4-100
TXVB-3001	Hi-Rel 5082-3001		6-57
TXVB-3002	Hi-Rel 5082-3002		6-57
TXVB-3039	Hi-Rel 5082-3039		6-57
TXVB-3042	Hi-Rel 5082-3042		6-60
TXVB-3043	Hi-Rel 5082-3043		6-60
TXVB-3077	Hi-Rel 5082-3077		6-57
TXVB-3080	Hi-Rel 5082-3080		6-63
TXVB-3141	Hi-Rel 5082-3141		6-69
TXVB-3168	Hi-Rel 5082-3168		6-66
TXVB-3188	Hi-Rel 5082-3188		6-66
TXVP-4001	Hi-Rel HPND-4001		6-49
TXVP-4005	Hi-Rel HPND-4005		6-51
TXVP-4050	Hi-Rel HPND-4050		6-49
TXVW-5300 Series	Hi-Rel HSCH-5300 Beam Leads		4-81
TXVW-5500 Series	Hi-Rel HSCH-5500 Beam Leads		4-83
TXVW-5800 Series	Hi-Rel HSCH-5800 Beam Leads		4-85
1N5165	Schottky Diode (Replaced by 5082-2301)		4-47
1N5166	Schottky Diode (Replaced by 5082-2302)		4-47
1N5167	Schottky Diode (Replaced by 5082-2303)		4-47
1N5711	HV Gen. Purpose Schottky Diode (5082-2800)	5082-0024	4-47
1N5712	General Purpose Schottky Diode (5082-2810)	5082-0087	4-47
1N5719	PIN Diode (Similar to 5082-3039)	5082-0012	6-29
1N5767	PIN Diode (Similar to 5082-3080)	5082-0025	6-29
1N6263	General Purpose Schottky Diode (HSCH-1001)		4-47
10514A	Double Balanced Mixer 0.2-500 MHz		11-4
10514B	Double Balanced Mixer 0.2-500 MHz		11-4
10514C	Double Balanced Mixer 0.2-500 MHz		11-4
10534A	Double Balanced Mixer 0.05-150 MHz		11-4
10534B	Double Balanced Mixer 0.05-150 MHz		11-4
10534C	Double Balanced Mixer 0.05-150 MHz		11-4
2N6617	Low Noise Transistor (HXTR-6101)	HXTR-6001	3-90

MODEL NO.	DESCRIPTION	GENERIC CHIP	PAGE NO.
2N6617TXV	Hi-Rel 2N6617	HXTR-6001	3-139
2N6618	Low Noise Transistor (HXTR-6103)	HXTR-6001	3-96
2N6618TXV	Hi-Rel 2N6618	HXTR-6001	3-139
2N6679	General Purpose Transistor (HXTR-2101)	HXTR-2001	3-31
2N6679TXV	Hi-Rel 2N6679	HXTR-2001	3-112
2N6701	Linear Power Transistor (HXTR-5101)	HXTR-5001	3-78
2N6701TXV	Hi-Rel 2N6701	HXTR-5001	3-134
2N6741	Low Noise Transistor	HXTR-5001	3-84
2N6741TXV	Hi-Rel 2N6741	HXTR-5001	3-134
2N6742	Low Noise Transistor	HXTR-6001	3-93
2N6742TXV	Hi-Rel 2N6742	HXTR-6001	3-139
2N6743	Low Noise Transistor	HXTR-6001	3-99
2N6743TXV	Hi-Rel 2N6743	HXTR-2001	3-139
2N6838	General Purpose Transistor (HXTR-3103)	HXTR-3001	3-39
2N6838TXV	Hi-Rel 2N6838	HXTR-3001	3-116
2N6839	Linear Power Transistor (HXTR-3104)	HXTR-3002	3-42
2N6839TXV	Hi-Rel 2N6839	HXTR-3002	3-120
5082-0001	High Speed Switch PIN Chip		6-12
5082-0008	Step Recovery Diode Chip		7-6
5082-0009	X-Band Schottky Detector Chip		4-15
5082-0012	PIN Switching Diode Chip		6-12
5082-0013	Low V_F Mixer/Zero Bias Detector Schottky Chip		4-15
5082-0015	Step Recovery Diode Chip		7-6
5082-0017	Step Recovery Diode Chip		7-6
5082-0018	Step Recovery Diode Chip		7-6
5082-0020	Step Recovery Diode Chip		7-6
5082-0021	Step Recovery Diode Chip		7-6
5082-0023	X-Band Schottky Mixer Chip		4-15
5082-0024	High Voltage Switching Schottky Chip		4-15
5082-0025	AGC PIN Chip		6-12
5082-0029	Ku-Band Schottky Mixer Chip		4-15
5082-0030	PIN Switching Diode Chip		6-12
5082-0032	Step Recovery Diode Chip		7-6
5082-0034	VHF/UHF Switching PIN Chip		6-12
5082-0039	AGC PIN Chip (Replaced by HPND-0002)		6-12
5082-0041	X-Band Schottky Mixer Chip		4-15
5082-0047	PIN Switching Diode Chip		6-12
5082-0057	General Purpose Schottky Diode Chip		4-15
5082-0058	General Purpose Schottky Diode Chip		4-15
5082-0087	General Purpose Schottky Chip		4-15
5082-0090	Step Recovery Diode Chip		7-6
5082-0094	General Purpose Schottky Diode Chip		4-15
5082-0097	General Purpose Schottky Chip		4-15
5082-0112	Step Recovery Diode	5082-0015	7-8
5082-0113	Step Recovery Diode		7-8
5082-0114	Step Recovery Diode		7-8
5082-0132	Step Recovery Diode	5082-0015	7-11
5082-0151	Step Recovery Diode	5082-0018	7-8
5082-0153	Step Recovery Diode	5082-0018	7-8
5082-0180	Step Recovery Diode	5082-0032	7-8

MODEL NO.	DESCRIPTION	GENERIC CHIP	PAGE NO.
5082-0241	Step Recovery Diode	5082-0032	7-11
5082-0253	Step Recovery Diode	5082-0018	7-11
5082-0300	Step Recovery Diode	5082-0017	7-11
5082-0310	Step Recovery Diode	5082-0021	7-11
5082-0320	Step Recovery Diode	5082-0020	7-11
5082-0335	Step Recovery Diode		7-11
5082-0800	Step Recovery Diode		7-11
5082-0803	Step Recovery Diode		7-8
5082-0805	Step Recovery Diode		7-11
5082-0810	Step Recovery Diode		7-11
5082-0815	Step Recovery Diode		7-8
5082-0820	Step Recovery Diode	5082-0090	7-11
5082-0821	Step Recovery Diode	5082-0090	7-11
5082-0825	Step Recovery Diode	5082-0090	7-8
5082-0830	Step Recovery Diode	5082-0020	7-11
5082-0833	Step Recovery Diode	5082-0020	7-8
5082-0835	Step Recovery Diode	5082-0008	7-11
5082-0840	Step Recovery Diode	5082-0008	7-8
5082-0885	Step Recovery Diode	5082-0008	7-11
5082-1001	High Conductance Diode (1N4456)		5-9
5082-1002	High Conductance Diode		5-9
5082-1006	High Conductance Diode		5-9
5082-2080	Batch Matched 5082-2835 Schottky		4-47
5082-2200	Hermetic Stripline Schottky Diode	HSCH-5316	4-55
5082-2201	Batch Matched 5082-2200	HSCH-5317	4-55
5082-2202	Hermetic Stripline Schottky Diode	HSCH-5316	4-55
5082-2203	Batch Matched 5082-2202	HSCH-5317	4-55
5082-2207	Stripline Schottky Diode	HSCH-5316	4-55
5082-2208	Batch Matched 5082-2207	HSCH-5317	4-55
5082-2209	Stripline Schottky Diode	HSCH-5316	4-55
5082-2210	Batch Matched 5082-2209	HSCH-5317	4-55
5082-2231	Low V_F Hermetic Stripline Schottky Quad	5082-9397	4-60
5082-2233	Low V_F Hermetic Stripline Schottky Quad	5082-9397	4-60
5082-2263	Hermetic Stripline Schottky Ring Quad	5082-9396	4-60
5082-2271	Low V_F Stripline Schottky Diode Quad	5082-9395	4-60
5082-2272	Low V_F Stripline Schottky Diode Quad	5082-9395	4-60
5082-2273	Ku Band Schottky Mixer Diode	5082-0029	4-63
5082-2274	Matched pair of 5082-2273	5082-0029	4-63
5082-2277	C-Band Stripline Schottky Ring Quad	5082-9394	4-60
5082-2279	Low V_F Broadband Stripline Schottky Quad	5082-9397	4-60
5082-2280	Low V_F Broadband Stripline Schottky Quad	5082-9399	4-60
5082-2291	Stripline Schottky Ring Quad	5082-9696	4-60
5082-2292	Stripline Schottky Ring Quad	5082-9696	4-60
5082-2294	Stripline Schottky Ring Quad	5082-9698	4-60
5082-2295	X-Band Low V_F Schottky Diode	5082-0013	4-63
5082-2296	Matched pair of 5082-2295	5082-0013	4-63
5082-2297	X-Band Low V_F Schottky Diode	5082-0013	4-63
5082-2298	Matched pair of 5082-2297	5082-0013	4-63
5082-2301	Schottky Barrier Diode		4-47

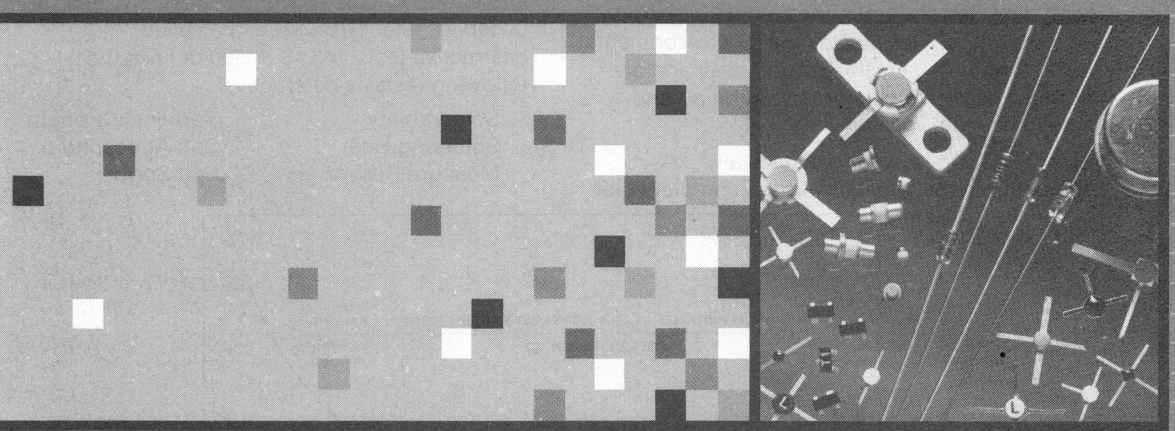
MODEL NO.	DESCRIPTION	GENERIC CHIP	PAGE NO.
5082-2302	Schottky Barrier Diode		4-47
5082-2303	Schottky Barrier Diode		4-47
5082-2305	Schottky Barrier Diode		4-47
5082-2306	Matched pair of 5082-2301		4-47
5082-2308	Matched pair of 5082-2303		4-47
5082-2350	Schottky Barrier Diode		4-63
5082-2351	Matched pair of 5082-2350		4-63
5082-2356	Matched Encapsulated Bridge Quad		4-47
5082-2370	Matched Quad of 5082-2303 Unconnected		4-47
5082-2396	Matched Encapsulated Ring Quad		4-47
5082-2400	Schottky Barrier Diode		4-63
5082-2401	Matched pair of 5082-2400		4-63
5082-2520	Schottky Barrier Diode		4-63
5082-2521	Matched pair of 5082-2520		4-63
5082-2565	Schottky Barrier Diode		4-63
5082-2566	Matched pair of 5082-2565		4-63
5082-2701	X-Band Schottky Mixer Diode	5082-0023	4-63
5082-2702	X-Band Schottky Mixer Diode	5082-0023	4-63
5082-2706	Matched pair of 5082-2701	5082-0023	4-63
5082-2707	Matched pair of 5082-2702	5082-0023	4-63
5082-2711	X-Band Schottky Mixer Diode	5082-0023	4-63
5082-2712	Matched pair of 5082-2711	5082-0023	4-63
5082-2713	X-Band Schottky Mixer Diode	5082-0023	4-63
5082-2714	Matched pair of 5082-2713	5082-0023	4-63
5082-2723	Ku Band Schottky Mixer Diode	5082-0029	4-63
5082-2724	Matched pair of 5082-2723	5082-0029	4-63
5082-2750	Schottky Detector Diode	5082-0009	4-74
5082-2751	Schottky Detector Diode	5082-0009	4-74
5082-2755	Schottky Detector Diode		4-74
5082-2765	Low V_F Hermetic Stripline Schottky	HSCH-5336	4-55
5082-2766	Batch Matched 5082-2765	HSCH-5337	4-55
5082-2774	Low V_F Stripline Schottky Diode	HSCH-5336	4-55
5082-2775	Batch Matched 5082-2774	HSCH-5337	4-55
5082-2785	Low V_F Hermetic Stripline Schottky	HSCH-5336	4-55
5082-2786	Batch Matched 5082-2785	HSCH-5337	4-55
5082-2787	Schottky Detector Diode		4-74
5082-2794	Low V_F Stripline Schottky Diode	HSCH-5336	4-55
5082-2795	Batch Matched Pair of 5082-2794	HSCH-5337	4-55
5082-2800	HVGenPurpose Schottky Barrier Diode(1N5711)	5082-0024	4-47
5082-2804	Matched Pair of 5082-2800 Unconnected	5082-0024	4-47
5082-2805	Matched Quad 5082-2800 Unconnected	5082-0024	4-47
5082-2810	General Purpose Schottky Diode (1N5712)	5082-0087	4-47
5082-2811	General Purpose Schottky Diode	5082-0097	4-47
5082-2813	Matched Bridge Quad 5082-2811 Encapsulated	5082-0097	4-47
5082-2814	Matched Ring Quad 5082-2811 Encapsulated	5082-0097	4-47
5082-2815	Matched Quad 5082-2811 Unconnected	5082-0097	4-47
5082-2817	Schottky Barrier Diode	5082-0097	4-63
5082-2818	Matched pair of 5082-2817	5082-0097	4-63
5082-2824	Schottky Barrier Diode	5082-0097	4-74
5082-2826	Batch Matched Diode 5082-2811	5082-0097	4-47

MODEL NO.	DESCRIPTION	GENERIC CHIP	PAGE NO.
5082-2830	Monolithic Matched Schottky Diode Ring Quad	5082-9696	4-60
5082-2831	Low V_F Monolithic Matched Schottky Quad	5082-9697	4-60
5082-2835	Low Offset Schottky Diode		4-47
5082-2836	Batch Matched Diode 5082-2800	5082-0024	4-47
5082-2837	Schottky Diode Beam Lead		4-23
5082-2900	Schottky Barrier Diode		4-47
5082-2912	Match pair of 5082-2900 Unconnected		4-47
5082-2970	Matched Quad 5082-2900 Unconnected		4-47
5082-2997	Matched Bridge Quad 5082-2900 Encapsulated		4-47
5082-3001	RF PIN Diode	5082-0012	6-29
5082-3002	RF PIN Diode	5082-0012	6-29
5082-3039	RF PIN Diode	5082-0012	6-29
5082-3040	Stripline PIN Diode	5082-0012	6-35
5082-3041	Stripline PIN Diode	5082-0001	6-35
5082-3042	RF PIN Diode	5082-0001	6-29
5082-3043	RF PIN Diode	5082-0001	6-29
5082-3071	Microwave Limiter PIN Diode	5082-0001	6-33
5082-3077	VHF/UHF PIN Switching Diode	5082-0012	6-29
5082-3080	HF/VHF/UHFCurrent Cont. Resistor (1N5767)	5082-0025	6-29
5082-3081	HF/VHF/UHF Current Controlled Resistor	5082-0039	6-29
5082-3101	RF PIN Diode	5082-0012	6-46
5082-3102	RF PIN Diode	5082-0012	6-46
5082-3140	Hermetic Stripline PIN Diode	5082-0012	6-40
5082-3141	Hermetic Stripline PIN Diode	5082-0001	6-40
5082-3168	VHF/UHF Switching PIN Diode	5082-0034	6-29
5082-3170	Hermetic Stripline PIN Diode	5082-0030	6-40
5082-3188	VHF/UHF Switching PIN Diode	5082-0034	6-29
5082-3201	RF PIN Diode	5082-0012	6-46
5082-3202	RF PIN Diode	5082-0012	6-46
5082-3303	RF PIN Diode	5082-0030	6-46
5082-3304	RF PIN Diode	5082-0030	6-46
5082-3305	High Speed Switch PIN Diode	5082-0001	6-44
5082-3306	High Speed Switch PIN Diode	5082-0001	6-44
5082-3340	Stripline PIN Diode	5082-0030	6-35
5082-3379	VHF/UHF Attenuator PIN Diode	5082-0025	6-29
5082-3900	PIN Diode Beam Lead		6-22
5082-9394†	Beam Lead Quad		
5082-9395†	Beam Lead Quad		
5082-9396†	Beam Lead Quad		
5082-9397†	Beam Lead Quad		
5082-9398†	Beam Lead Quad		
5082-9399†	Beam Lead Quad		
5082-9696†	Beam Lead Quad		
5082-9697†	Beam Lead Quad		
5082-9891	X-Band Schottky Detector Chip		4-15
8761A	*SPDT Mechanical Switch DC-18 GHz*		8-2
8761B	*SPDT Mechanical Switch DC-18 GHz*		8-2
33000C	*Absorptive Modulator 1-4 GHz*		10-2
33000D	*Absorptive Modulator 1-4 GHz*		10-2
33001C	*Absorptive Modulator 8-18 GHz*		10-2

MODEL NO.	DESCRIPTION	GENERIC CHIP	PAGE NO.
33001D	*Absorptive Modulator 8-18 GHz*		10-2
33002A	*SRD Comb Generator Module 100 MHz*		12-2
33002B	*SRD Comb Generator Module 100 MHz*		12-2
33003A	*SRD Comb Generator Module 250 MHz*		12-2
33003B	*SRD Comb Generator Module 250 MHz*		12-2
33004A	*SRD Comb Generator Module 500 MHz*		12-2
33004B	*SRD Comb Generator Module 500 MHz*		12-2
33005C	*SRD Comb Generator Module 1000 MHz*		12-2
33005D	*SRD Comb Generator Module 1000 MHz*		12-2
33008C	*Absorptive Modulator 3.7-8 GHz*		10-2
33008D	*Absorptive Modulator 3.7-8 GHz*		10-2
33016C	*SPDT General Purpose Microwave Switch 0.1-18 GHz*		10-8
33102A	*SPST General Purpose Microwave Switch 0.1-18 GHz*		10-10
33104A	*SPST General Purpose Microwave Switch 0.1-18 GHz*		10-10
33132A	*SPST Low Loss Microwave Switch 0.1-18 GHz*		10-16
33134A	*SPST Low Loss Microwave Switch 0.1-18 GHz*		10-16
33142A	*SPST Fast Microwave Switch 0.1-18 GHz*		10-20
33144A	*SPST Fast Microwave Switch 0.1-18 GHz*		10-20
33150A	*Microwave Bias Network 0.1-18 GHz*		13-2
33190B	*Switch Driver for Fast SPST PIN Switches*		10-24
33602A	*General Purpose Microwave SPST Switches, DC-18 GHz*		10-10
33604A	*General Purpose Microwave SPST Switches, DC-18 GHz*		10-10
33632A	*Low Loss Microwave SPST Switches, DC-18 GHz*		10-16
33634A	*Low Loss Microwave SPST Switches, DC-18 GHz*		10-16
33642A	*Fast Microwave SPST Switches, DC-18 GHz*		10-20
33644A	*Fast Microwave SPST Switches, DC-18 GHz*		10-20

High Reliability

- Introduction 1-2
- Reliability Testing 1-2
- Role of Military Specifications 1-3
- Hi-Rel Screened Products 1-5
- Marking, Packaging, Shipping and Handling ...1-12



HIGH RELIABILITY

Introduction

For over 20 years, MSD has been extensively involved in many military and space oriented High Reliability (Hi-Rel) Test programs. The inherent reliability and proven performance of our products has provided a vehicle with which to build a strong record of performance in the demanding requirements of space programs. By having a large group of Marketing and Product Assurance personnel dedicated to the service of Hi-Rel customers, HP has been frequently called upon to provide the high performance, highly reliable components demanded by many military and commercial space probe and satellite programs. Among the many space programs using HP Microwave Semiconductor Division products are Apollo, Viking, Intelsat, Space Shuttle, Indiasat, G-Star, and Westar.

This section of the catalog describes the use of Hi-Rel testing, to demonstrate the quality and reliability of semiconductor devices.

Reliability Testing

Reliability testing is designed to demonstrate the ability of a device to meet electrical requirements over its specified life to a designated confidence level. To achieve this confidence, Hi-Rel devices are either 100% tested or qualified by testing a random sample of devices from the lot.

The purpose of 100% testing is to verify the stability of the devices in the completed lot, and verify that devices are in the useful life period (see Figure 1). These tests may be environmental tests or functional tests (i.e. electrical) and are normally referred to as preconditioning and screening tests, respectively.

Sample testing is used to statistically demonstrate the capability of the completed lot of devices to operate successfully under the specified test conditions. A sample test plan specifies the acceptance level required before the lot is considered qualified. This test plan depends on the level of reliability required, and is mathematically derived.

If a lot does not successfully pass a particular test during Group A sampling, that lot is 100% retested for that particular parameter. This 100% testing will remove any non-conforming devices thereby ensuring that the remaining lot is reliable.

Sample tests are usually divided into Group A, Group B, and Group C tests.

Group A tests are electrical tests used to demonstrate that the parts meet the functional requirements of the particular specification to which they are purchased.

Group B tests are environmental and life tests. They are used to demonstrate the ability of the lot sample to survive test conditions.

Group C tests are also environmental and life tests. They are used to demonstrate the ability of the generic device to meet the requirements of each test. These tests are run infrequently, hence, they are often referred to as periodic tests.

Group B and C life tests verify the length of the useful life period under specified bias conditions (see Figure 1). Some of the Group B and Group C tests render devices unserviceable. These tests are called destructive tests. MIL-S-19500 defines the following tests as destructive:

Solderability	Terminal Strength
Soldering Heat	Salt Atmosphere
Moisture Resistance	Salt Spray

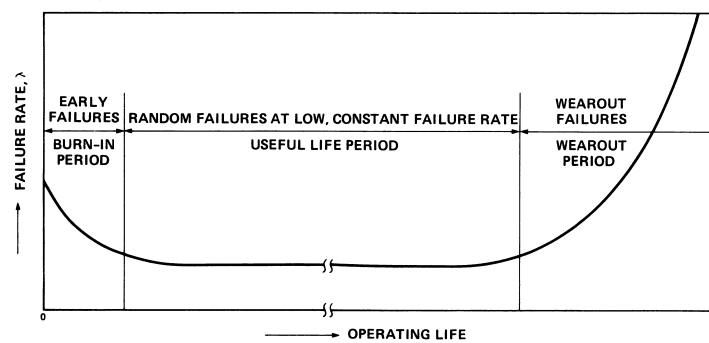


Figure 1.

Role of Military Specifications

There are numerous specifications associated with electronic devices. MIL-S-19500 and MIL-STD-750 are most frequently used to specify test programs, methods and conditions for discrete semiconductors.

MIL-S-19500 is the general specification for discrete semiconductor components. It defines test sequences to achieve different levels of reliability. MIL-STD-750 defines the actual tests and screening methods, conditions and pass/fail criteria as required by MIL-S-19500. These tests are divided into three categories:

a. Environmental Tests (1000 Series)
b. Mechanical Tests (2000 Series)
c. Electrical Tests (3000 and 4000 Series)

Environmental Tests

MIL-STD-750 Method	Test Type	Purpose of Test/Simulated Operation	Frequency of Testing
1001	Barometric Pressure	Simulates non-pressurized portion of aircraft at high altitude. (Required for products with V_{BR} > 200 V only.)	Group C (periodic)
1021	Moisture Resistance	Simulates tropical environment of high heat and humidity.	Group C (periodic)
1022	Resistance to Solvents	Simulates cleaning of boards after device installation. Verifies marking permanency.	Group B
1026	Steady State Life (λ)	Simulates accelerated electrical operation. t = 1000 hours.	Group C (periodic)
1027	Steady State Life (LTPD)	Simulates accelerated electrical operation. t = 340 hours.	Group B
1031	Hi-Temp. Non-Op. Life (λ)	Simulates accelerated shelf life. t = 1000 hours.	Group C (periodic)
1032	Hi-Temp. Non-Op. Life (LTPD)	Simulates accelerated shelf life and effect of exposure to temperture. t = 24 hours for screen, t = 340 hours for Group B.	100% screen and Group B.
1038 Diodes	Hi-Temp. Reverse Bias and Burn-in	Simulates time and stress of actual life use on devices. Verifies that devices are in the useful life period.	100% Screen.
1039 Transistors	Hi-Temp. Reverse Bias and Burn-in	Simulates time and stress of actual life use on devices. Verifies that devices are in the useful life period.	100% Screen.
1041	Salt Atmosphere	Simulates accelerated exposure to sea coast environment.	Group C (periodic)
1051	Thermal Shock (Temperature Cycling)	Simulates transfer of parts between extreme environmental conditions.	100% Screen.
1056	Thermal Shock (Glass Strain)	Ensures mechanical integrity by subjecting devices to sudden changes in temperature.	Group C (periodic)
1071	Fine Leak/Gross Leak	Verifies that packaging is hermetically sealed.	100% screen.

Mechanical Tests

MIL-STD-750 Method	Test Type	Purpose of Test/Simulated Operation	Frequency of Testing
2006	Constant Acceleration	Ensures die attach and wire bond integrity.	100% screen.
2016	Mechanical Shock	Verifies devices resistance to mechanical stresses.	Group C (periodic)
2017	Die Shear Test	Verifies integrity of die to package bond.	In process/Group B
2026	Solderability	Confirms that the leads are able to take an even coating of solder with minimum voids.	Group B
2031	Soldering Heat	Determines the devices resistance to the high temperature encountered during soldering.	Guaranteed by design.
2036 A, D, E, F	Terminal Strength	Simulates the leads ability to withstand specified tension, torque, and fatigue.	Group C
2037	Bond Strength	Verifies integrity of chip to package interconnection	In process/Group B
2052	PIND (Partical Impact Noise Detection Test)	Detects loose particles in the package cavity.	100% screen
2056	Vibration Variable Frequency	Simulates mechanical performance of the device when subjected to vibration within the specified frequency range.	Group C (periodic)
2066	Physical Dimensions	Verifies that dimensions meet the design and specification criteria.	Group C (periodic)
2071	Visual and Mechanical	Ensures that marking and packaging meet specified requirements.	Group A
2072	Internal Visual (pre-cap)	Ensures high visual quality of end product.	100% screen
2073	Die Visual	Ensures high quality, defect-free semiconductor die for assembly use.	100% screen
2074	Internal Visual (through glass)	Ensures high visual quality of end product.	100% screen
2075	Decap Design Verification	Verifies that design and construction meet specifications.	Group B
2076	X-Ray	Non-destructive test performed after final seal that verifies seal integrity, bond integrity, and particle-free cavity.	100% screen
2077	Scanning Electron Microscope (SEM)	Verifies quality and acceptability of metallization on semiconductor dice.	Samples from each wafer or lot

Electrical Tests

Class 3000 and 4000 tests define the acceptable testing methods for semiconductor products.

Hi-Rel Screened Products

Hewlett-Packard provides two types of Hi-Rel products: DESC qualified (JAN) and Standard Hi-Rel.

DESC Qualified Products (JAN)

Since a great number of reliability tested devices are used in military programs, the JAN (Joint Army-Navy) system has been established by the U.S. government to provide standardized levels of reliability at minimum cost to all users. There are two major advantages to the JAN type products. First, the specification, and thus the reliability level of the device, is pre-specified for the buyer, eliminating costly creation of special procurement documents. Second, JAN devices can be manufactured in large quantities with subsequent cost reductions.

Three levels of JAN devices are offered by Hewlett-Packard:

1. JAN —
   Shipment lots have had Group B tests performed successfully on a sample basis.
2. JAN TX —
   The shipment lots have been subjected to 100% screening tests. Individual devices have been serialized, and drift data has been recorded. Group B sample data is then done after screening.
3. JAN TXV —
   These are the same level as JAN TX with the additional requirement of a pre-closure/ pre-paint visual inspection.

Standard Hi-Rel Programs

Since the advantages of products tested to well established reliability standards can be of significant value to reliabililty oriented customers, HP makes available a number of products that have been tested to the same reliability level as the JAN type devices, but have HP part numbers and meet HP designated electrical specifications. These are our "TX" products. Typical screening programs are set forth in the Hi-Rel data sheets.

Hewlett-Packard provides standard Hi-Rel programs which are patterned after MIL-S-19500. These programs are designed to:

1. Eliminate the costly requirements of generating Hi-Rel specifications.
2. Offer improved delivery for these Hi-Rel devices.
3. Provide assistance in writing Hi-Rel specifications.

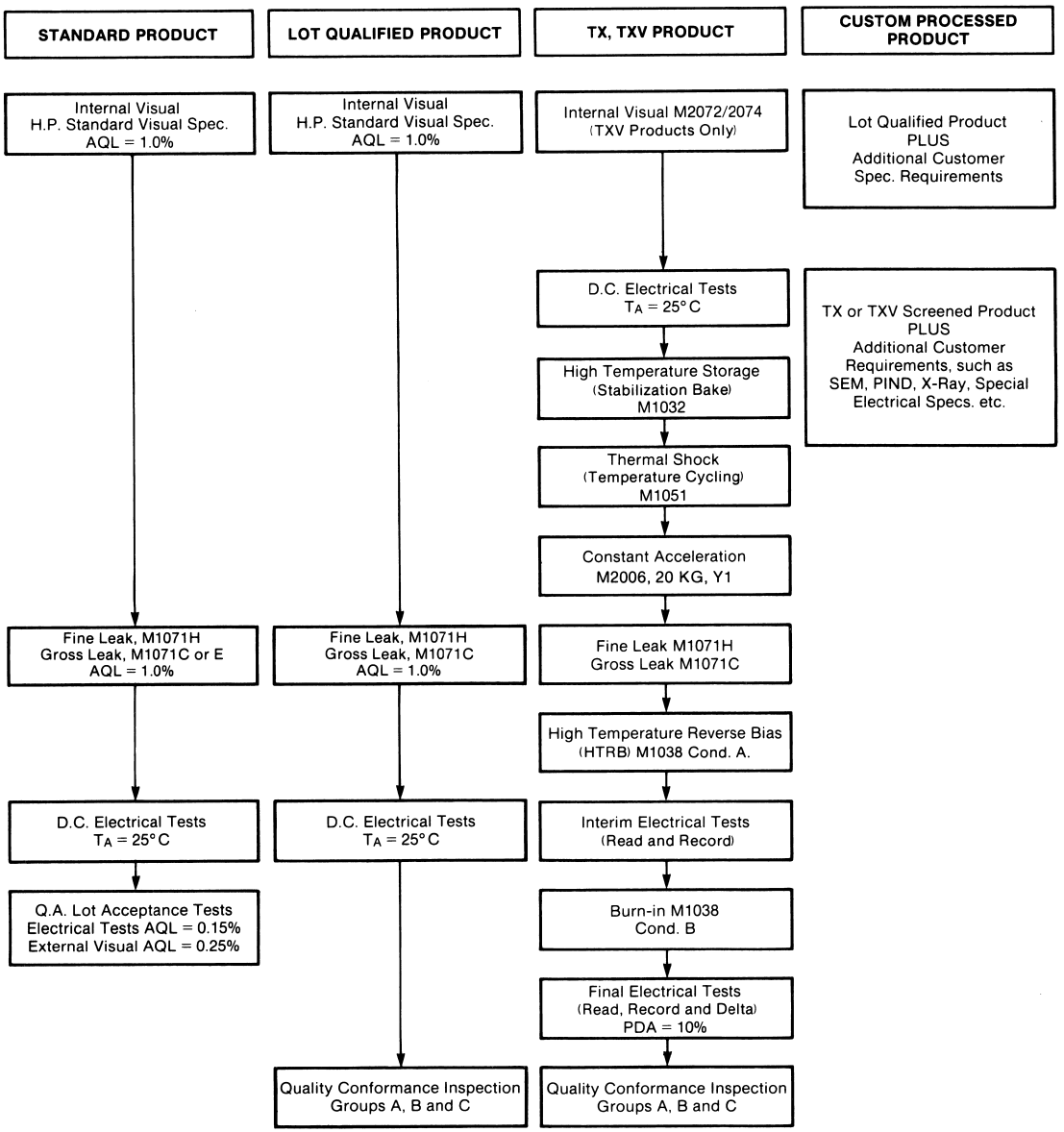
Products available from HP may be classified into four categories:

a. Dice
b. Beam lead devices
c. Glass packaged devices
d. Ceramic packaged devices

Hi-Rel screening requirements vary slightly due to the unique properties of each category. The tables that follow list these screening programs along with the qualification and quality conformance testing performed for each category. Screening programs for each category have been designed to verify the reliability of the end product.

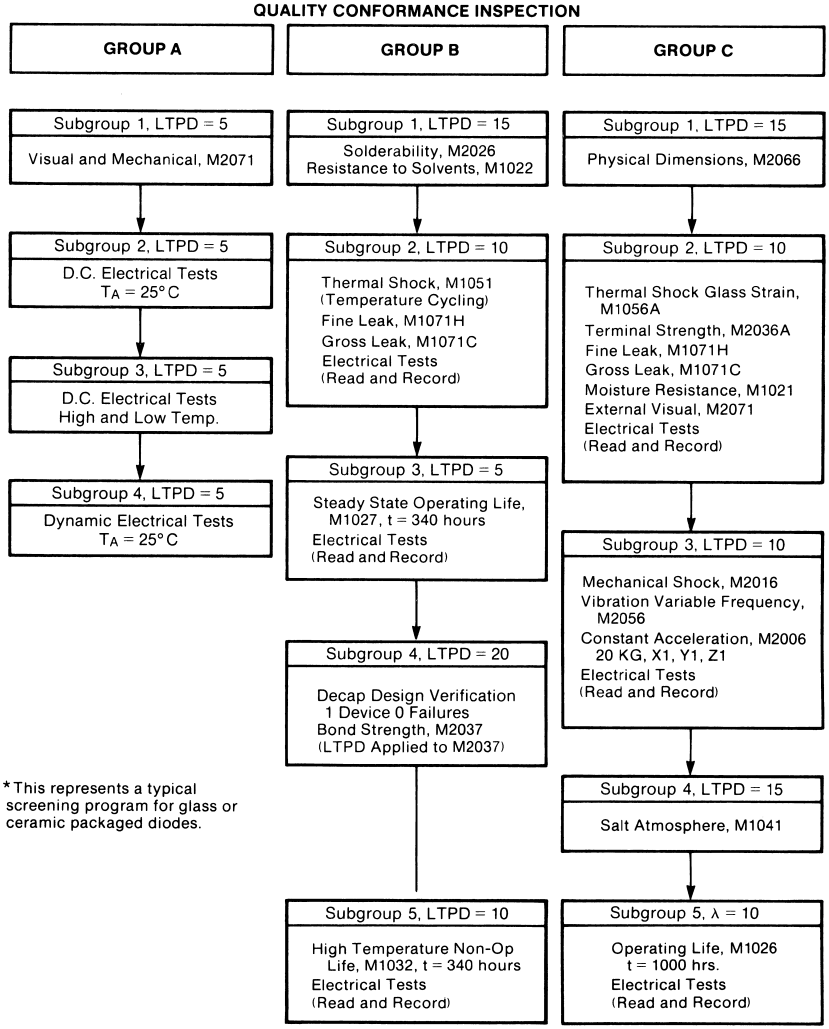
Diode Test and Screening Options (Typical)*

(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)



Diode Test and Screening Options (Typical)* (cont)

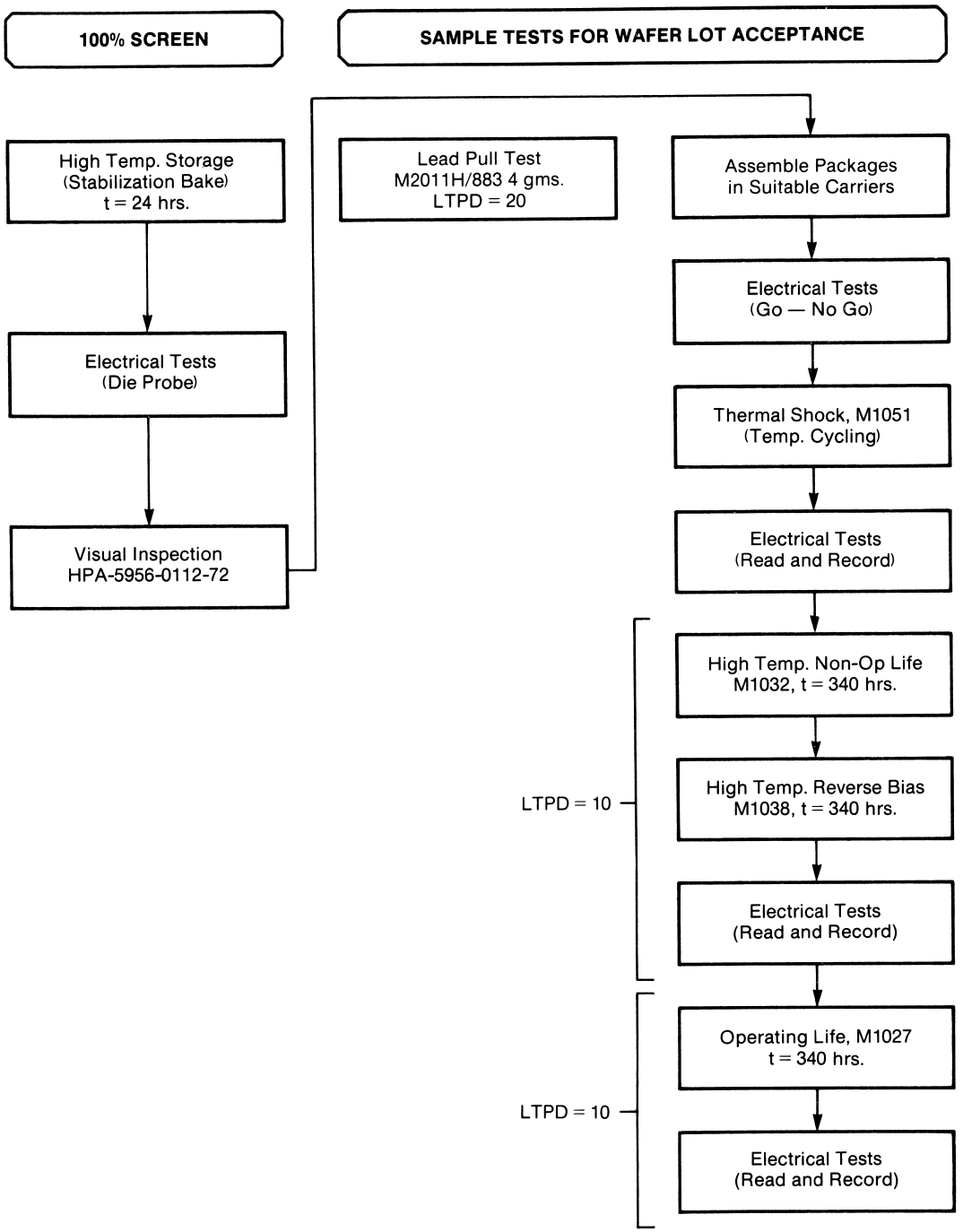
(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)



*This represents a typical screening program for glass or ceramic packaged diodes.

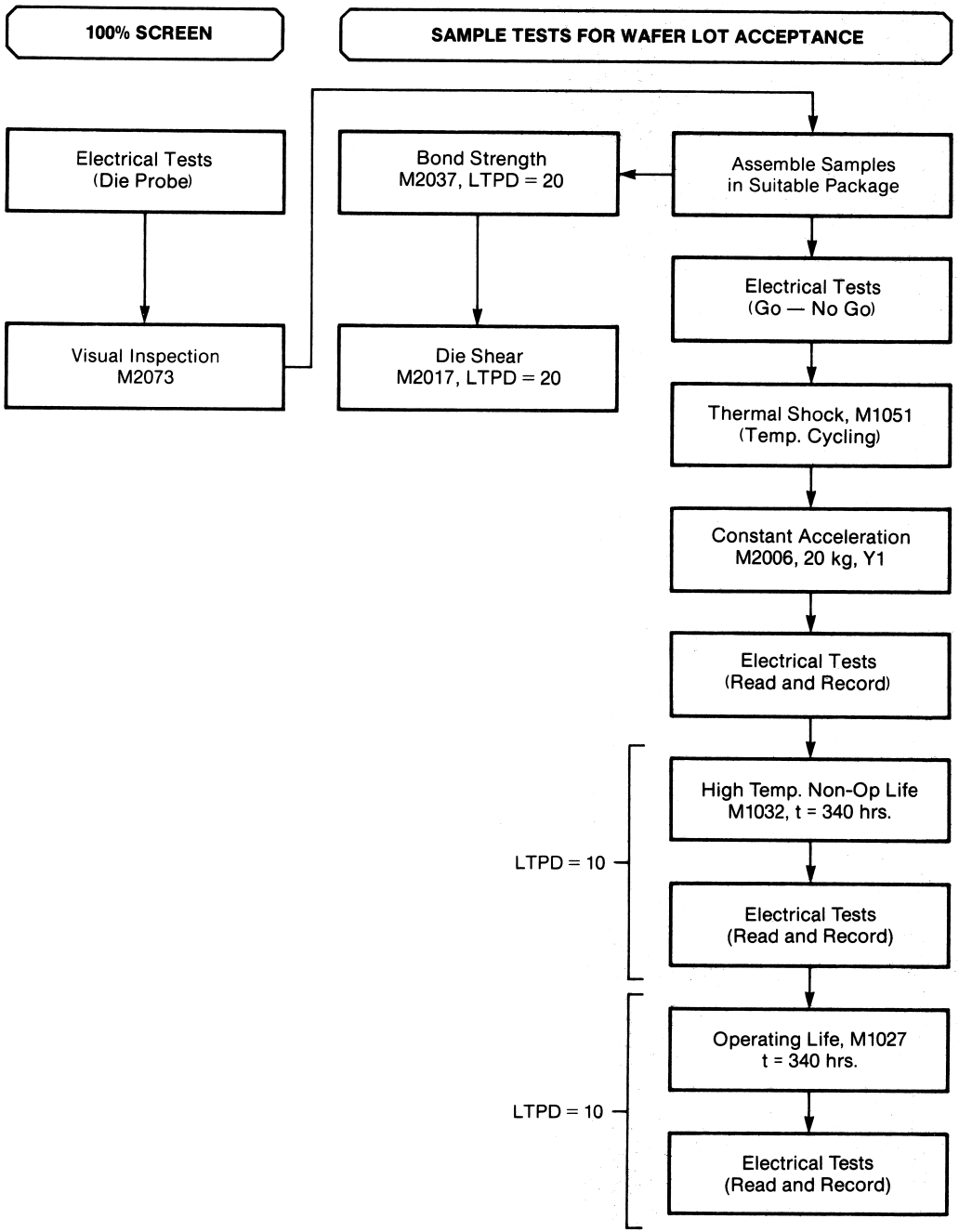
Hi-Rel Beam Lead Diode Test/Screen Program (Typical)

(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)



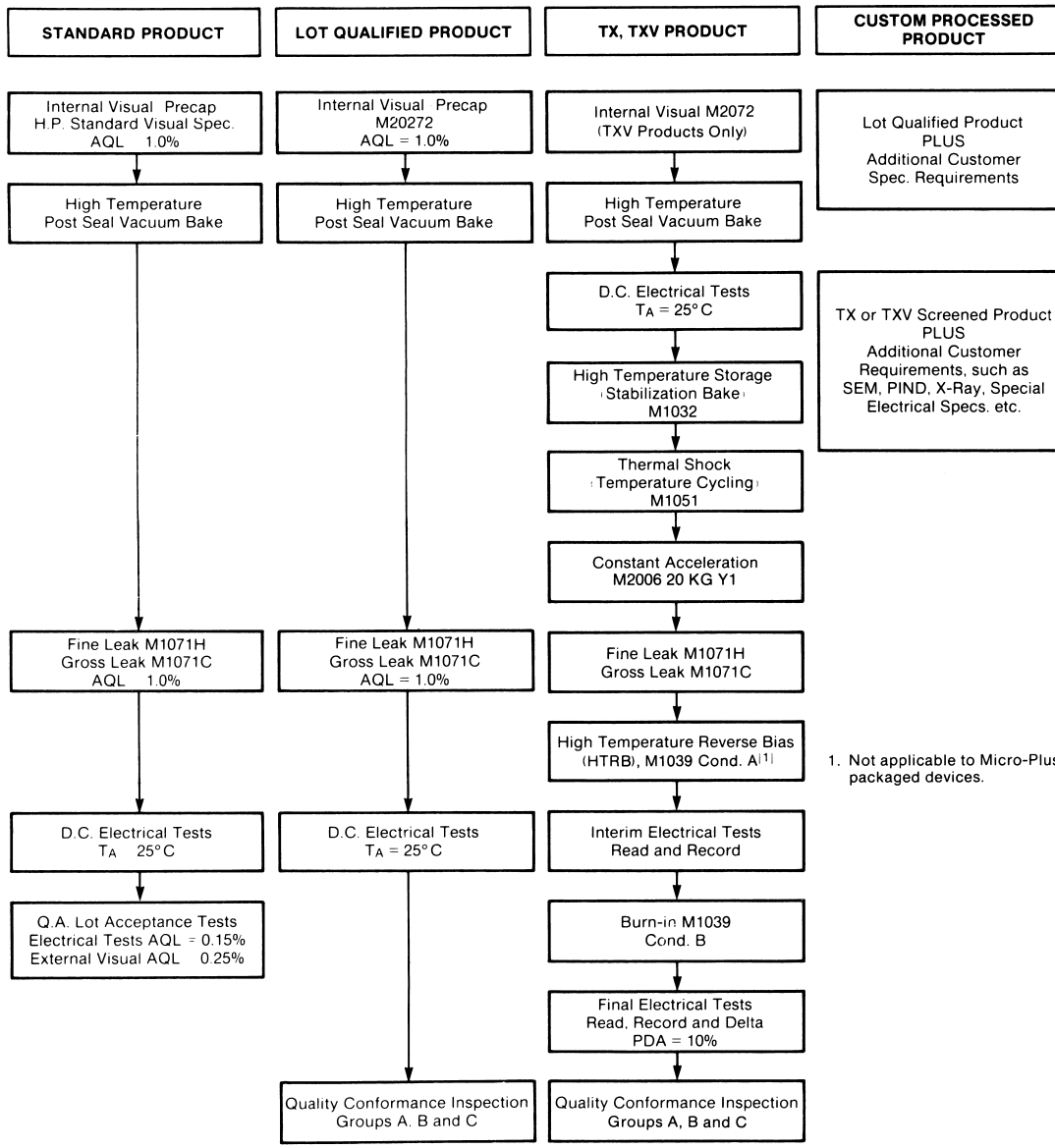
Hi-Rel Chip Diode Test/Screen Program (Typical)

(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)



Transistor Test and Screening Options (Typical)

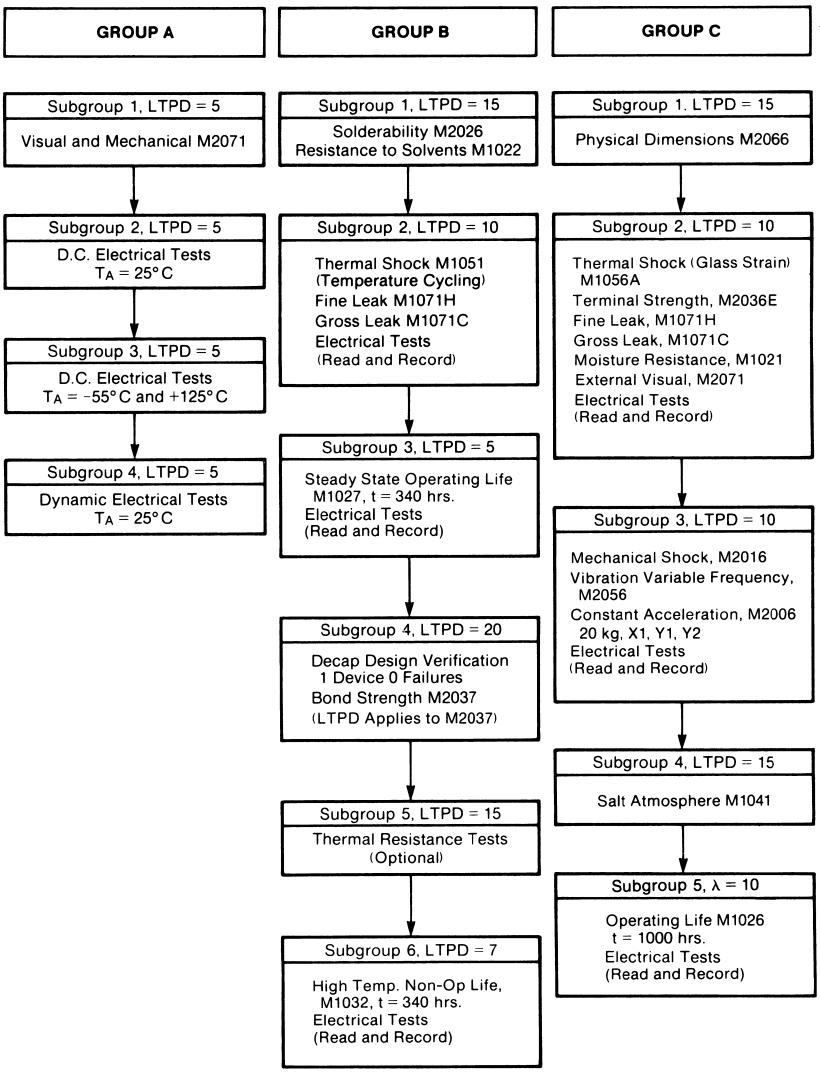
(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)



Transistor Test and Screening Options (Typical) (cont)

(All Methods (M) are per MIL-STD-750, Unless Otherwise Specified)

QUALITY CONFORMANCE INSPECTION



Marking, Packaging, Shipping and Handling

Device and container marking is dependent on the type of device as shown below:

Device	Device Marking				Typical Container/Marking
Dice	None				100 dice per waffle pack. Label on waffle pack.
Beam Lead	None				25 beamleads per gel pack. Label on gel pack.
Glass Package	DESC				Bulk or corregated insert (10 each), packaged in antistatic bag. Label on bag. Tape and Reel
	JAN	JAN TX	JAN TXV	HP, Hi-Rel	
	JIN ABCD[1] AQIM[2]	JXIN ABCD[1] AQIM[2]	JVIN ABCD[1] AQIM[2]	ABC DEF[1] XXX[3]	
Ceramic Package	None on small packages. Marking varies on larger packages.				Individual or multiple packaging. Label on packaging container.

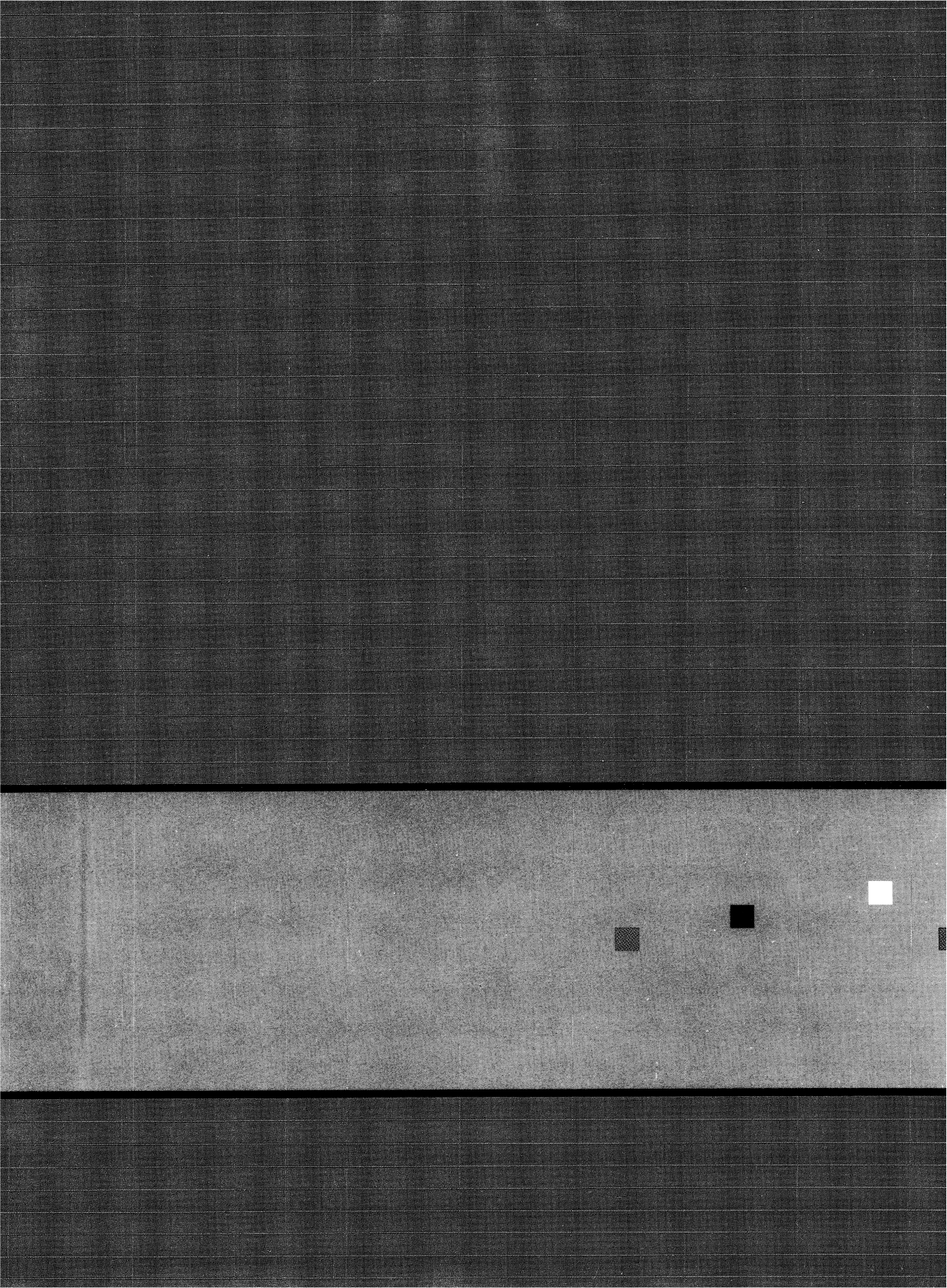
Notes:

1. Part Number.
2. Manufacturers ID.
3. Data Code.

Label Marking:

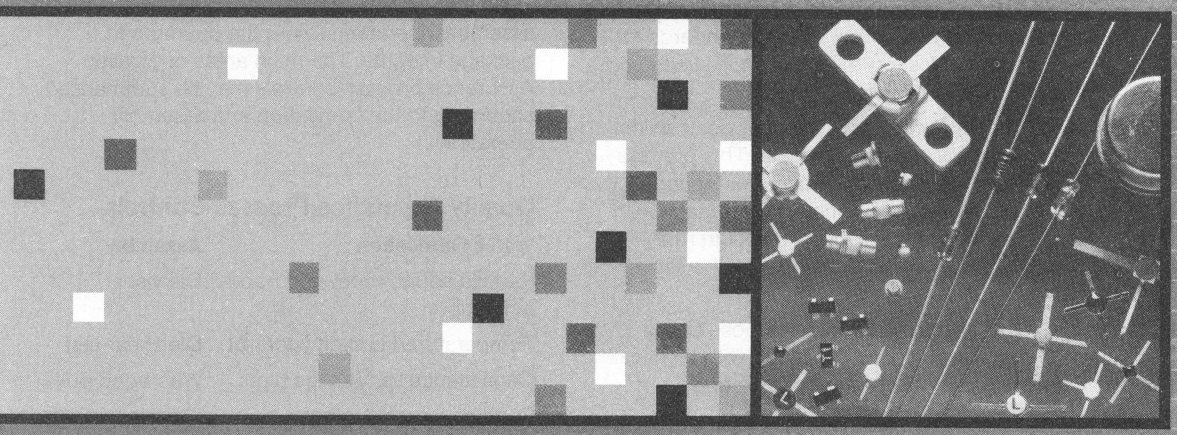
Hewlett-Packard	Lot Number
Part Number	Country of Origin
Date Code	Quantity

All devices are electrostatic sensitive. Packaging used is antistatic and impregnated with conductive material to provide adequate protection from electrostatic discharge damage. At a receiving station, the parts should be treated as ESD sensitive material and appropriate handling procedures must be used to avoid degradation due to electrostatic discharge.



Quality Assurance

- Philosophy 2-2
- In-process Control and Reliability Testing 2-2
- Process Controls 2-2
- Life and Environment Stress Tests 2-3
- Reliability Assessment and Prediction 2-3
- Monitor Program 2-5



QUALITY ASSURANCE CONCEPTS AND METHODOLOGY

Quality Philosophy

Recognizing the increasing importance of microwave component reliability for the consumer, industrial, and military markets, the Microwave Semiconductor Division (MSD) of Hewlett-Packard has committed itself to achieve error free performance at all levels of manufacturing and to deliver the highest level of product quality and reliability performance. Three basic ingredients are integrated into the manufacture of reliable microwave components:

- The device must be designed with a technical understanding of the user's applications and quality requirements.
- The device must be manufactured with the optimum state-of-the-art technology for the application.
- Controls must be established in the manufacture of the device.

As a major manufacturer of microwave products, MSD produces a broad family of many devices. Since it is not practical, technically necessary, nor cost effective to qualify each of these products via life and environmental testing, the logical approach has been to differentiate assembly/package related failure mechanisms from failure modes associated with the wafer fabrication process. This "die process" and "package product" approach to reliability has been a consideration in the new military standards for microelectronic testing/reliability and is used at MSD with the following definitions:

- **Die Process Family** consists of devices which have identical wafer processing. This premise recognizes that component geometry and layout of a product will have little impact on reliability because established design rules apply to all products fabricated by the same process.
- **Package/Assembly Family** are those of like construction and are assembled with identical materials, manufacturing controls and operations.

Component reliability estimation can therefore be achieved with a high confidence level from environmental and life testing data derived from various product families. Accelerated stress testing techniques are continuously employed to obtain definitive working knowledge of reliability performance, whereby the resulting information is used to predict long-term device reliability for the intended application.

In-process Control and Reliability Testing

The reliability performance of microwave components can be affected by numerous operations associated with device manufacturing; among these being:

- Wafer fabrication process/technology
- Device design and layout
- Packaging design
- The manufacturing processes
  - — Wafer fabrication
  - — Package materials
  - — Assembly materials and procedures
- In-process controls
- Final electrical test procedures
- Quality Assurance inspection procedures
- Post-assembly reliability screening

One of the most important aspects of insuring quality and reliability is through adequate in-process controls of these operations. Wafer fabrication controls provide the assembly operation with a high quality and reliable chip, while the process controls associated with the assembly operation assure the optimum in package integrity. The main areas of Quality Assurance process controls may be summarized according to the fabrication and assembly operations:

Quality Assurance Process Controls

Wafer Fabrication	Assembly
Particle count, room and hood ambient	Die visual
Temperature/Humidity control	Die shear test
Capacitance vs. Voltage plots	Wire bond pull
Furnace tube cleaning	Pre-seal visual
Deionized water checks	Hermeticity
Metal thickness monitor	Electrical test
Metal SEM monitor	
Inspection of starting material	

Life and Environmental Stress Tests

To ensure the highest quality product commensurate with the intended use of the device, numerous life and environmental tests have been designed to assess device performance. The majority of these tests are designed to simulate more extreme operating conditions than would actually be encountered in most practical applications. This ensures the reliability performance of the device relative to its intended application. Typical device testing at MSD generally comprises the following environmental and life tests:

Life Tests

High Temperature Reverse Bias (HTRB)

Operating Life

High Temperature Operating Life (HTOL)

High Temperature Storage Life (HTSL)

Environmental Tests

Moisture Resistance	Hermeticity
Solderability	Mechanical Shock
Thermal Shock	Lead Fatigue
Temperature Cycling	Vibration Variable Frequency
Power Cycling	Vibration Fatigue
Terminal Strength	Constant Acceleration
	Salt Atmosphere

Specific methods and conditions of these tests are in compliance with MIL-STD-202, MIL-STD-750, and MIL-STD-883 test specifications, depending upon the nature of the device being tested and its functional classification. For more information on these testing programs please refer to the High Reliability section of this catalog.

Reliability Assessment and Prediction

Numerous concepts and mathematical models have been proposed to assess the reliability performance of semiconductor components. Of these, essentially three fundamental equations are widely used in the industry for reliability assessment and prediction of failure rate:

- The failure rate equation, λ
- The probability of survival, P_S
- The Arrhenius equation for determining the activation energy of thermal processes, E_a

The **Failure Rate Equation** relates to the population of units failed under life testing and the duration of the test. It is defined by the relationship

$$\lambda = \frac{N_F}{N_O t}$$

where

λ = assessed failure rate

N_F = quantity of failures occuring in a time interval t

N_O = quantity of acceptable devices at zero hours

t = time interval or duration of test

Generally it is more meaningful to discuss failure rates in terms of the Mean Time To Failures or MTTF, which is the reciprocal of the failure rate and expressed as MTTF = $1/\lambda$. It is important to recognize that both λ and MTTF are statistical averages and apply only to the useful life of the product.

The **Probability of Survival** is the likelihood that a particular device will survive for a given period of operating time and may be expressed as:

$$P_S = e^{-\lambda t} = e^{-t/(MTTF)}$$

where

t = operating time of the device

λ = failure rate = 1/MTTF

The third mathematical relationship of importance to reliability is a form of the **Arrhenius Equation**, which relates the rate of a thermally accelerated process to temperature. Expressed in terms of the failure rate λ and the **Activation Energy** (E_a) for the process takes the form:

$$E_a = \frac{kT_2T_1}{(T_2-T_1)} \ln \frac{\lambda_2}{\lambda_1}$$

where

E_a = Activation Energy

k = Boltzmann's Constant (8.63×10^{-5} eV/°K)

T_i = Absolute temperatures at which the failure rates λ_i were measured

λ_i = Failure rate at temperature T_i

From this relationship, the failure rate at some temperature other than the test temperature can be determined provided the activation energy of

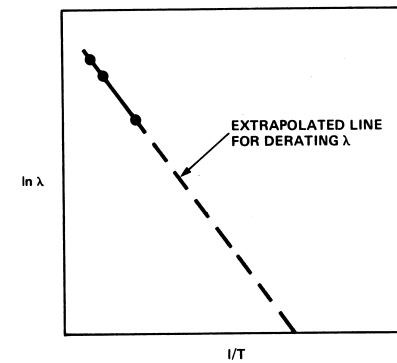
the failure mode is known. More important, the activation energy can be determined for various thermally activated processes. This allows the reliability analysts to fingerprint specific failure mechanisms and hence predict the reliability performance of a product as a function of time and temperature. In practice, the failure mechanism of a device is not clearly understood or the activation energy of the processes are not known. Hence the derating of failure rates from accelerated temperature stress testing is usually accomplished by the use of the non-integrated Arrhenius equation:

$$\ln \lambda = - \frac{E_a}{kT} + \ln A$$

where A is a constant.

A plot of $\ln \lambda$ vs. T^{-1} will yield a straight line as illustrated, with a slope equal to $-E_a k^{-1}$.

ARRHENIUS PLOT



Extrapolation of this line to the junction temperature (T_J) of the device or ambient temperature (T_A) allows the analytical extraction of the failure rate at the temperature of interest. This procedure of derating λ assumes that the failure rate is a linear function of time at a fixed level of stress.

Reliability Product Monitor Program

The accompanying program matrix has been constructed by the Reliability Group to provide an active monitor on the reliability performance of our products; the intent of the program being:

- To provide a periodic on-going evaluation of our product reliability.
- Maintain a pulse on fabrication and assembly operations.
- Identify, via long-term stress testing, the limitations of our products and thereby provide future direction to engineering design, development, and manufacturing improvements.

Fabrication and assembly variables were considered in the construction of the matrix to assure that these products would best represent all product families and their associated processes.

In addition to the following listed products, all new products must pass an extensive reliability test program prior to introduction. This ensures that the tradition of high quality is upheld in all new devices.

Life and Environmental Test Matrix[1]

Life/Environmental Stress	Test Method	Stress Condition	Minimum Stress Duration
Operating Life	MIL-STD-750 Method 1026.3	$T_J/T_{CH} \leq 200°C$	1000 hours
High Temperature Storage	MIL-STD-883 Method 1008	Test Condition D $T_A = 200°C$	2000 hours
HTRB	MIL-STD-750 Method 1038/1039	Test Condition A $T_A = 200°C$	1000 hours
Temperature Cycling	MIL-STD-883 Method 1010	Test Condition D –65° to 200° C	100 cycles
Power Cycling	MIL-STD-750 Method 1036.3	$\Delta T_C = 100°C$	5000 cycles
Thermal Shock	MIL-STD-883 Method 1011	Test Condition D –65° to 200° C	100 cycles
Solderability	MIL-STD-202 Method 208	T_{PbSn} at 230° C	5 second dwell
Hermeticity	MIL-STD-883 Method 1014	Kr-85/dry N_2 Penetrant dye	N/A
Moisture Resistance	MIL-STD-202 Method 106	65° C/98% R.H.	10 day
Vibration Variable Frequency	MIL-STD-750 Method 2056	100 to 2,000 Hz	4 cycles at Sweep Rate < 4 minutes
Mechanical Shock	MIL-STD-883 Method 2002	Acceleration at 1,500 G's	0.5 msec. pulse duration
Terminal Strength	MIL-STD-750 Method 2036.3	TBA (Package Related)	30 second duration

Note:

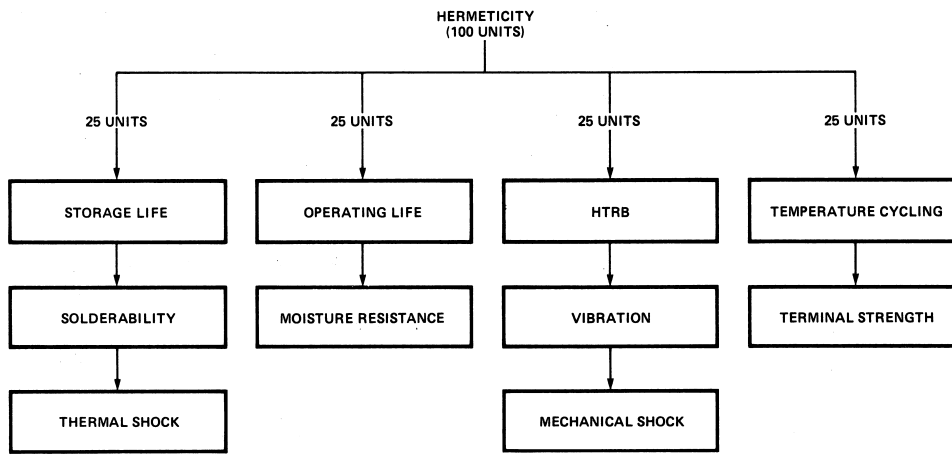
1. The intent of the monitor program is to maintain a pulse on the reliability performance of products.

Reliability Product Monitor Program

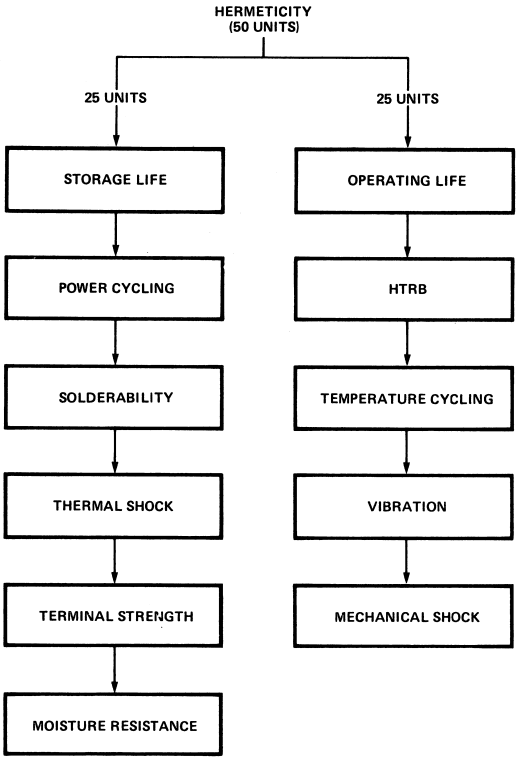
Product Line	Part Number	Quantity	Period of Testing	Life/Environmental Tests
RF Schottky	5082-2800	100	Semiannual	Operating Life
	HSCH-1001	100	Semiannual	HTRB[1]
	5082-2835	100	Semiannual	High Temperature Storage[1]
	5082-2831	100	Semiannual	Temperature Cycling
Microwave Schottky	5082-2200/2202	100	Semiannual	Thermal Shock
	5082-2301/2302	100	Semiannual	Hermeticity[1]
PIN/SRD	5082-3001	100	Semiannual	Solderability[1]
	5082-3080	100	Semiannual	Moisture Resistance
	HPND-4001/4050	100	Semiannual	Vibration Fatigue
	5082-0180	100	Semiannual	Mechanical Shock
	5082-3188	100	Semiannual	Terminal Strength[1]
Bipolar Transistors	HXTR-5103	60	Semiannual	Power Cycling[1]
		30[2]		Moisture Resistance
	HXTR-6103/6104	60	Semiannual	Pressure Pot[1]
		30[2]		Lead Fatigue[1]
	HXTR-3101/3102	90	Semiannual	Salt Atmosphere
				Solvent Resistance

Notes:
1. Where applicable.
2. May be electrical rejects.

DIODES

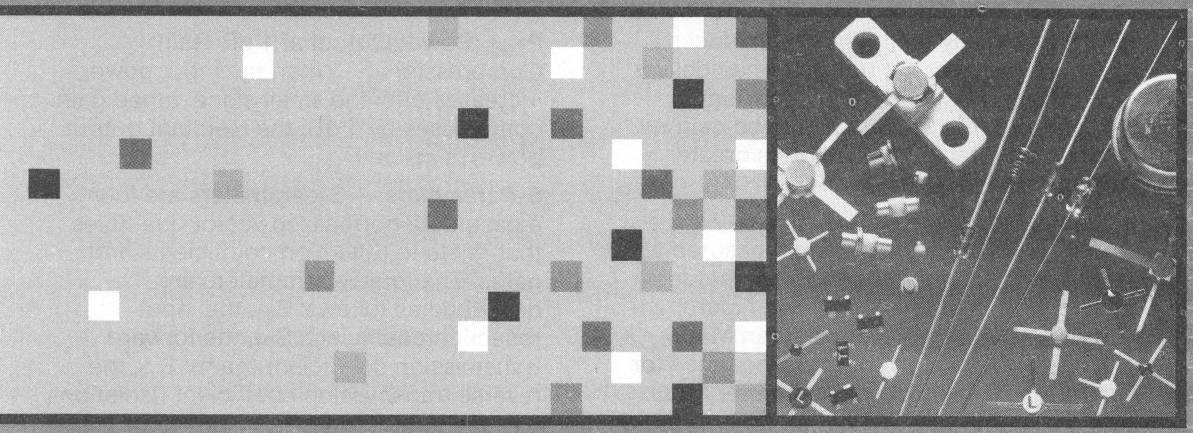


BIPOLAR TRANSISTORS
(Method of Sequential Testing)



Silicon Bipolar Transistors

- Characteristics and Applications 3-2
- Package Selection Guide 3-6
- Transistor Selection Guide 3-8
- Alphanumeric Index 3-10
- Chips 3-12
- Chip Equivalent Circuits 3-30
- Packaged Devices 3-31
- High Reliability 3-111
- Reliability Data 3-147
- Abstracts of Application Notes and Bulletins . 3-150



SILICON BIPOLAR TRANSISTORS CHARACTERISTICS AND APPLICATIONS

The Silicon Bipolar transistor is a semiconductor device, with amplification due to current gain. The advantages silicon bipolar transistors have over other transistor types are mature technology (both in the understanding of the device physics and the device design), low cost, and proven reliability. Therefore, silicon bipolar transistors offer designers a familiar, reliable, cost effective solution to many of their design needs.

The Hewlett-Packard silicon bipolar transistors are each characterized using standard D.C. and R.F. specifications. The typical D.C. specifications include pertinent junction parameters (such as junction breakdown voltages and leakage currents) and Beta (h_{FE}). The R.F. and D.C. parameters include the following:

NF_{MIN} (Minimum Noise Figure) — The lowest possible noise figure of the transistor when properly biased and matched for low noise operation.

f_T (Transition frequency, "Gain Bandwidth Product") — f_T is the theoretical frequency at which the common emitter gain $|h_{fe}|$ is unity (0 dB).

MAG (Maximum Available Gain) — MAG is theoretically the highest transducer power gain that the transistor can deliver at a given frequency. It is important to recognize that MAG can only be defined when the Stability Factor, K, is greater than 1.0.

G_A (Noise Figure Gain) — Noise Figure Gain is the transducer gain measured with the same source impedance as that for obtaining the Minimum Noise Figure, NF_{MIN}. G_A is usually lower than MAG since the optimum source impedance for NF_{MIN} is usually different than for MAG.

G_T (Tuned Gain) — Tuned Gain is transducer power gain measured with the transistor's input and output impedances matched (tuned).

G_{1dB} (Associated 1 dB Compressed Gain) — Gain associated with P_{1dB}. G_{1dB} is 1 dB less than the transistor small signal gain when it is matched for maximum output power.

$|S_{21E}|^2$ (Transducer Gain) — The forward transmission gain of a transistor with a 50 Ω source and load.

C_{cb} (Reverse Transfer Capacitance) —The collector-base capacitance of a transistor measured with the emitter connected to the guard of a four-terminal pair capacitance meter.

$NF_{(50\ \Omega)}$ (50 Ω Noise Figure) — The noise figure of a transistor with a 50 Ω source impedance.

Γ_O (Gamma Optimum) — The source reflection coefficient that yields the lowest possible noise figure of a transistor (F_{MIN}).

IP_3 (Third Order Intercept Point) — The intersections of the straight line extensions of the fundamental output and third order intermodulation products of a transistor.

P_{1dB} (Power Output at 1 dB Gain Compression) — When the input power increases until the small signal tuned gain compresses by 1 dB, the resultant output power is called P_{1dB}.

S-Parameters — S-parameters are four measurable normalized vector quantities that relate to reflection coefficients and gains. The four S-parameters are described as follows: S_{11}, the input reflection coefficient; S_{21}, the forward transmission coefficient (gain); S_{12}, the reverse transmission coefficient (isolation), S_{22}, the output reflection coefficient.

BV_{CBO} (Collector Base Breakdown Voltage with Open Emitter) — DC breakdown voltage, collector to base, with the emitter open circuited ($I_E = 0$). This is the highest breakdown voltage of the collector-base junction. BV_{CBO} is the highest voltage at which the transistor can be operated without damage in Common Base circuits.

BV_{CEO} (Collector Emitter Breakdown Voltage with Open Base) — DC breakdown voltage, collector to emitter, with the base open circuited ($I_B = 0$). BV_{CEO} is usually lower (as much as 50%) than BV_{CBO}.

BV_{CES} (Collector Emitter Breakdown Voltage with Base Shorted) — DC breakdown voltage, collector to emitter, with the base short circuited to the emitter ($V_{BE} = 0$).

BV_{EBO} (Emitter Base Breakdown Voltage) — DC breakdown voltage, emitter to base reverse biased, with open circuited collector ($I_C = 0$).

h_{FE} (Common Emitter Curent Gain, Beta) — Common emitter DC current gain, the ratio of the total DC collector current to the total DC base current.

I_{EBO} (Emitter Base Leakage Current) —DC leakage current, reverse biased emitter base, with collector open ($I_C = 0$).

I_{CBO} (Collector Base Leakage Current) — DC leakage current, reverse biased collector to base, with emitter open circuited ($I_E = 0$).

I_{CEO} (Common Emitter Leakage Current with Base Open) — DC leakage current, collector to emitter, with base open circuited ($I_B = 0$).

I_{CES} (Collector Emitter Leakage Current with Base Shorted) — DC leakage current, reversed biased collector to emitter, with base shorted to emitter ($V_{EB} = 0$).

$I_{C\ (MAX)}$ (Absolute Maximum Collector Current) — $I_{C\ (MAX)}$ is the maximum collector current that the transistor can safely withstand for an extended period.

$P_{T\ (MAX)}$ (Maximum Power Dissipation) — $P_{T\ (MAX)}$ is the maximum total DC and microwave power dissipation the transistor can safely withstand.

$T_{J\ (MAX)}$ (Maximum Junction Temperature) —The maximum junction temperature at which the reverse biased collector base junction can be maintained without irreversibly damaging the transistor.

Included in the data sheets are the "Absolute Maximum Ratings" which are those conditions that, when exceeded, will cause permanent damage to the device. These are the standard maximum ratings used for derating purposes.

The Hewlett-Packard Silicon Bipolar product line has seven basic transistor types; the HXTR-2000 series, the HXTR-3000 series, the HXTR-4000 series, the HXTR-5000 series, the HXTR-6000 series, the HXTR-7000 series, and the new HSMX-3XXX series.

The HXTR-2000 Series

The HXTR-2000 series is designed for general gain amplifier stage requirements. The HXTR-2000 series devices have 2 μm emitter widths, and 450 mW of total device dissipation. These transistors have high maximum available gain (typically 17.5 dB at 2 GHz), high linear output power (P_{1dB} typically 20 dBm at 2 GHz) with a small degradation in noise figure (typically 2.2 dB at 2 GHz). The HXTR-2000 series is offered in two rugged hermetic packages, the HPAC-100 and the HPAC-70GT. The HXTR-2101 is packaged in the HPAC-100, and the HXTR-2102 is packaged in the HPAC-70GT. The HXTR-2001, the transistor chip, is also available for hybrid applications. All of the HXTR-2000 series devices are characterized from 100 MHz to 6.5 GHz.

The HXTR-3000 Series

The HXTR-3000 series devices are designed for high volume, low cost applications in the VHF and UHF range. The HXTR-3000 series consists of three basic chips; the HXTR-3001, the HXTR-3002 and the HXTR-7011. The HXTR-3001 has high gain (typically 16 dB at 2 GHz), and low noise figure (typically 2.2 dB at 2 GHz). The HXTR-3001 is offered in the HPAC-100X (a low cost, rugged metal/ceramic package) as the HXTR-3101 and the HXTR-3103, and in the HPAC-100P (a low cost, microplastic package) as the HXTR-3121. The HXTR-3002 has high linear output power (typically 21 dBm at 1000 MHz) and high associated 1 dB compressed gain (typically 11.5 dB at 1000 MHz). The HXTR-3002 is also offered in the HPAC-100X, as the HXTR-3102 and the HXTR-3104. The HXTR-7011 has low noise figure (typically 1.9 dB at 26 GHz) and high associated gain (typically 13 dB at 2 GHz). The 7011 is offered in the HPAC-100P (a low cost, microplastic package) as the HXTR-3265. The three chips are available for hybrid applications. The HXTR-3000 series devices are characterized from 100 MHz to 4 GHz.

The HXTR-4000 Series

The HXTR-4101 is designed and characterized for common-base oscillator transistor applications. The device uses the HXTR-2001 chip packaged in the HPAC-100. The HXTR-4101 has typical output power (oscillator power) of 20 dBm at 4.3 GHz. This device is characterized from 1 GHz to 12 GHz.



The HXTR-4103, -4104 and -4105 are designed and characterized for common-collector transistor applications. The HXTR-4103 uses the HXTR-5002 chip packaged in the HPAC-200GB/GT. The HXTR-4013 has a typical output power of 30 dBm at 2 GHz. The HXTR-4104 uses the HXTR-3002 chip packaged in the HPAC-100X. The HXTR-4104 has a typical output power of 20 dBm at 4 GHz. The HXTR-4105 uses the HXTR-7011 chip packaged in the HPAC-100X. The HXTR-4015 has a typical output power of 14 dBm at 6 GHz.

The HXTR-5000 Series

The HXTR-5000 series devices are designed for those applications where high linear output is required. The HXTR-5000 series consists of two basic transistor chips, the HXTR-5001 and the HXTR-5002. Both transistor chips have 2 μm emitter widths and Ta_2N ballast resistors. The HXTR-5001 has a total device dissipation of 700 mW, while the HXTR-5002 has a device dissipation of 2.7 W. The HXTR-5001 has higher linear output power than the HXTR-2000 series (P_{1dB} typically 23 dBm at 2 GHz), and high associated 1 dB compressed gain (typically 13.5 dB of 2 GHz). The HXTR-5001 is offered in the HPAC-100 and the HPAC-200. The HXTR-5101 is in the HPAC-100, and the HXTR-5103 is in the HPAC-200. The HXTR-5002 has the highest linear output power of the transistor product line (typically 29 dBm at 2 GHz) and high associated 1 dB compressed gain (typically 12.5 dB gain at 2 GHz). The HXTR-5002 devices are offered in the hermetic packages HPAC-200 GB/GT and the HPAC-200. The HXTR-5102 is packaged in the HPAC-200 GB/GT, and the HXTR-5104 is packaged in the HPAC-200. Both chip transistors, the HXTR-5001 and HXTR-5002, are available for hybrid applications. All the HXTR-5000 series devices are characterized from 100 MHz to 6 GHz.

The HXTR-6000 Series

The HXTR-6000 series devices are designed for those applications where low noise performance is a premium. These devices stem from two basic transistor chips, the HXTR-6001 and HXTR-2001. The transistors using the HXTR-6001 have the lowest noise figure and the highest associated gain. The HXTR-6001 transistor has a 1 μm emitter width, a typical noise figure of 1.7 dB (at 2 GHz) with 13 dB of associated gain, and 150 mW of total device dissipation. The HXTR-6001 transistors are offered in the HPAC-70GT and the HPAC-100. The HXTR-6101 and the HXTR-6102 (low noise selection of the HXTR-6101) are offered in the HPAC-70GT. The HXTR-6103 and the HXTR-6104 (low noise selection of the HXTR-6103) are in the HPAC-100. The chip, the HXTR-6001, is available for hybrid applications. The HXTR-6105 and the HXTR-6106 use the HXTR-2001 chip. The HXTR-6105 is packaged in the HPAC-100, and the HXTR-6106 is packaged in the HPAC-70GT. The HXTR-6105 and the HXTR-6106 are low noise selections of the HXTR-2101 and the HXTR-2102 respectively. These devices are all characterized from 100 MHz to 6 GHz, or higher.

The HXTR-7000 Series

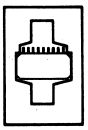
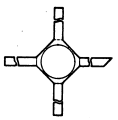
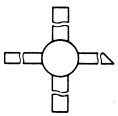
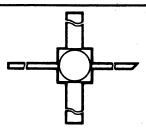
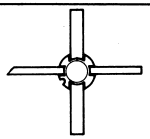
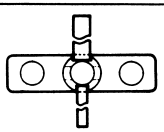
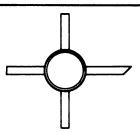
The HXTR-7000 series devices are designed for those applications where low noise and high linear power output performances are required. The chip, the HXTR-7011, has 0.6 μm emitter widths, a typical noise figure of 1.7 dB with an associated gain 13 dB at 2 GHz and 600 mW total device power dissipation. The HXTR-7011 is offered in two rugged hermetic packages: the high volume, low cost HPAC-100X (HXTR-3615, HXTR-3645, HXTR-3675) and the HPAC-100 (HXTR-7111). All the HXTR-7000 series devices are characterized from 100 MHz to 6000 MHz.



The HSMX-3000 Series

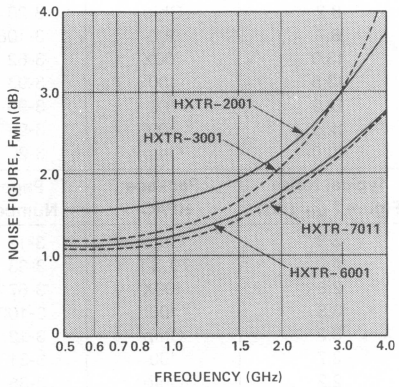
The HSMX series devices are designed for high volume, low cost, surface mount applications in the VHF and UHF ranges. The HSMX-3000 series consists of two basic chips: the HXTR-3001 and the HXTR-7011. The HSMX-3131 contains the HXTR-3001 chip and has high gain (typically 14 dB at 1 GHz) and low noise figure (typically 1.8 dB at 1 GHz). The HSMX-3635 contains the HXTR-7011 chip and also has high gain (typically 15 dB at 1 GHz) and low noise figure (typically 1.4 dB at 1 GHz). Both parts are packaged in the low cost SOT-23 plastic package. The devices are characterized from 100 MHz to 2 GHz.

SILICON BIPOLAR TRANSISTOR PACKAGE SELECTION GUIDE

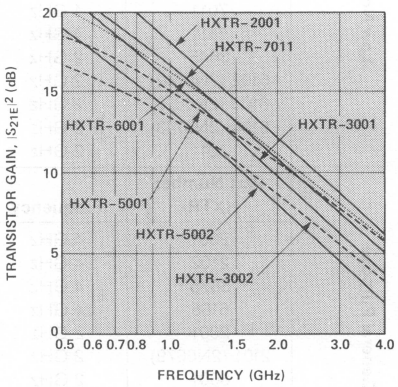
	High Performance						Low Cost		
	Low Noise		General Purpose		Linear Power		Low Noise	General Purpose	Linear Power
	4 GHz (HXTR-)	2 GHz (HXTR-)	4 GHz (HXTR-)	2 GHz (HXTR-)	4 GHz (HXTR-)	2 GHz (HXTR-)	1 GHz (HXTR-)	1 GHz (HXTR-)	1 GHz (HXTR-)
 Generic CHIP	6001 7011	6001 7011	2001	2001 3001	5001 5002	3002 5001 5002	7011	3001 7011	3002 7011
 HPAC-100X	3675	3645	3675	3103 3645 4104 4105 (oscillator)		3104	3615 3645	3101 3615	3102 3104 3615
 HPAC-70GT	6101	6102	2102	2102 6106					
 HPAC-100	7111	6103 6104	2101 6105 4101 (oscillator)	2101	5101	5101			
 HPAC-200					5103	5103 5104			
 HPAC-200GB/GT					5102	5102 4103 (oscillator)			
 HPAC-100P								3625	3121
 23								HSMX-3635	HSMX-3131
 143								HSMX-3655	HSMX-3151

BIPOLAR TRANSISTOR CHIP SELECTION GUIDE

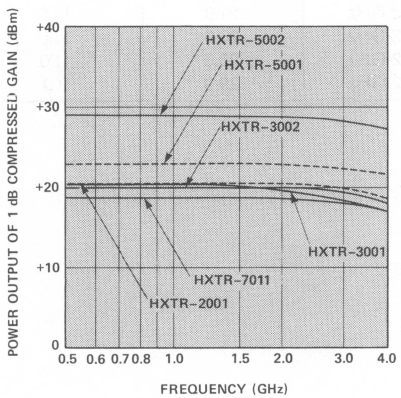
TYPICAL NOISE FIGURE vs. FREQUENCY (CHIP TRANSISTORS)



TYPICAL TRANSISTOR GAIN vs. FREQUENCY



TYPICAL P_{1dB} vs. FREQUENCY



HXTR-3001: 1 GHz @ 21
2 GHz @ 19

HXTR-3002: 2 GHz @ 20
4 GHz @ 18.5

PART NUMBER SELECTION GUIDE

High Performance						
	Part Number HXTR-	**Frequency**	**Typical Noise Figure F_{MIN} (dB)**	**Typical Associated Gain G_a (dB)**	**Package HPAC-**	**Page Number**
Low Noise	3675	4 GHz	2.8	8.3	100X	3-67
	6001	4 GHz	2.7	9.0	Chip	3-24
	6101 (2N6617)	4 GHz	2.8	9.0	100	3-90
	7011	4 GHz	2.8	8.2	Chip	3-26
	7111	4 GHz	2.8	8.7	100	3-108
	3645	2 GHz	1.7	13.0	100X	3-62
	6102 (2N6742)	2 GHz	1.6	13.5	100	3-93
	6103 (2N6618)	2 GHz	1.8	12.0	100	3-96
	6104 (2N6743)	2 GHz	1.5	12.5	100	3-99
	7011	2 GHz	1.7	13.0	Chip	3-26
	Part Number HXTR-	**Frequency**	**Typical S_{21E}^2 (dB)**	**Typical Noise Figure F_{MIN} (dB)**	**Package HPAC-**	**Page Number**
General Purpose	2001	4 GHz	6.0	3.8	Chip	3-12
	2102	4 GHz	5.3	4.2	70 GT	3-33
	3675	4 GHz	4.4	2.8	100X	3-67
	6105	4 GHz	4.6	3.8	100	3-102
	2001	2 GHz	12.0	3.2	Chip	3-12
	2101 (2N6679)	2 GHz	11.0	2.7	100	3-31
	3001	2 GHz	9.8	2.2	Chip	3-35
	3103 (2N6838)	2 GHz	9.4	2.5	100X	3-39
	3645	2 GHz	9.8	1.7	100X	3-62
	6106	2 GHz	10.5	2.5	70 GT	3-105
	Part Number HXTR-	**Frequency**	**Typical P_{1dB} (dB)**	**Typical G_{1dB} (dB)**	**Package HPAC-**	**Page Number**
Linear Power	5001	4 GHz	22.0	8.0	Chip	3-18
	5002	4 GHz	27.5	7.5	Chip	3-21
	5101	4 GHz	22.0	7.5	100	3-76
	5102	4 GHz	27.5	7.0	200 GB/GT	3-81
	3002	2 GHz	21.0	13.5	Chip	3-16
	5001	2 GHz	23.0	13.5	Chip	3-18
	5002	2 GHz	29.0	12.5	Chip	3-21
	3104 (2N6839)	2 GHz	21.0	13.0	100X	3-42
	5101	2 GHz	23.0	13.0	100	3-76
	5103	2 GHz	23.0	11.0	200	3-84
	5104	2 GHz	29.0	9.0	200	3-87

PART NUMBER SELECTION GUIDE

Low Cost						
	Part Number HXTR-	**Frequency**	**Typical Noise Figure F_{MIN} (dB)**	**Typical Associated Gain G_a (dB)**	**Package HPAC-**	**Page Number**
Low Noise	7011	1 GHz	1.2	18.0	Chip	3-26
	3615	1 GHz	1.4	16.6	100X	3-52
	3645	1 GHz	1.2	17.5	100X	3-62
	3625	1 GHz	1.6	—	100P	3-55
	3635	1 GHz	1.4	—	SOT-23	3-58
	3655	1 GHz	1.4	—	SOT-143	3-65
	3121	1 GHz	1.2	—	100P	3-44
	3131	1 GHz	1.8	—	SOT-23	3-46
	3151				SOT-143	3-50
	Part Number HXTR-	**Frequency**	**Typical S_{21E}^2 (dB)**	**Typical Noise Figure F_{MIN} (dB)**	**Package HPAC-**	**Page Number**
General Purpose	3001	1 GHz	15.7	1.5	Chip	3-14
	3101	1 GHz	15.0	1.8	100X	3-35
	3103	1 GHz	15.0	1.7	100X	3-39
	3615	1 GHz	15.8	1.4	100X	3-52
	7011	1 GHz	16.5	1.2	Chip	3-26
	Part Number HXTR-	**Frequency**	**Typical P_{1dB} (dB)**	**Typical G_{1dB} (dB)**	**Package HPAC-**	**Page Number**
Linear Power	3002	1 GHz	22.0	18.0	Chip	3-16
	3102	1 GHz	21.0	15.0	100X	3-37
	3104	1 GHz	21.0	16.0	100X	3-42
	3615	1 GHz	19.0	19.0	100X	3-52
	7011	1 GHz	21.0	19.0	Chip	3-26
	Part Number HXTR-	**Frequency**	**Typical F_{MIN} (dB)**	**Typical P_{1dB} (dBm)**	**Package HPAC-**	**Page Number**
High Performance	3645	2 GHz	1.7	19.0	100X	3-62
	3675	4 GHz	2.8	17.5	100X	3-67
	7011	4 GHz	1.7	19.0	Chip	3-26

Oscillator				
Part Number HXTR-	**Frequency**	**Typical P_{OSC}(dBm)**	**Package HPAC-**	**Page Number**
4101	4.3 GHz	20.5	100	3-70
4103	2 GHz	30.0	200 GB/GT	3-72
4104	4 GHz	20.0	100X	3-74
4105	6 GHz	14.0	100X	3-76

BIPOLAR TRANSISTOR ALPHANUMERIC INDEX

MODEL NO.	DESCRIPTION	PAGE NO.
HSMX-3131	Surface Mount General Purpose Transistor	3-46
HSMX-3151*	Surface Mount General Purpose Transistor	3-50
HSMX-3635	Surface Mount General Purpose Transistor	3-58
HSMX-3655*	Surface Mount General Purpose Transistor	3-65
HXTR-2001	General Purpose Transistor Chip	3-12
HXTR-2101	General Purpose Transistor (2N6679)	3-31
HXTR-2101TXV	Hi-Rel HXTR-2101	3-112
HXTR-2102	General Purpose Transistor	3-33
HXTR-2102TXV	Hi-Rel HXTR-2102	3-112
HXTR-3001	General Purpose Transistor Chip	3-14
HXTR-3002	Linear Power Transistor Chip	3-16
HXTR-3101	Low Cost General Purpose Transistor	3-35
HXTR-3101TXV	Hi-Rel HXTR-3101	3-116
HXTR-3102	Low Cost Linear Power Transistor	3-37
HXTR-3102TXV	Hi-Rel HXTR-3102	3-120
HXTR-3103	General Purpose Transistor (2N6838)	3-39
HXTR-3103TXV	Hi-Rel HXTR-3103	3-116
HXTR-3104	Linear Power Transistor (2N6839)	3-42
HXTR-3104TXV	Hi-Rel HXTR-3104	3-120
HXTR-3121	Low Cost General Purpose Transistor	3-44
HXTR-3615	Low Cost Low Noise Transistor	3-52
HXTR-3615TXV	Hi-Rel HXTR-3615	3-124
HXTR-3625	Low Cost General Purpose Transistor	3-55
HXTR-3645	Low Cost High Performance Transistor	3-62
HXTR-3645TXV	Hi-Rel HXTR-3645	3-124
HXTR-3675	Low Cost High Performance Transistor	3-67
HXTR-3675TXV	Hi-Rel HXTR-3675	3-124
HXTR-4101	Oscillator Transistor	3-70
HXTR-4101TXV	Hi-Rel HXTR-4101	3-128
HXTR-4103	High Output Power Oscillator Transistor	3-72
HXTR-4103TXV	Hi-Rel HXTR-4103	3-128
HXTR-4104	Low Cost Oscillator Transistor	3-74
HXTR-4104TXV	Hi-Rel HXTR-4104	3-128
HXTR-4105	Low Cost Oscillator Transistor	3-76
HXTR-4105TXV	Hi-Rel HXTR-4105	3-128
HXTR-5001	Linear Power Transistor Chip	3-18
HXTR-5002	Linear Power Transistor Chip	3-21
HXTR-5101	Linear Power Transistor (2N6701)	3-78
HXTR-5101TXV	Hi-Rel HXTR-5101	3-134
HXTR-5102	Linear Power Transistor	3-81
HXTR-5102TXV	Hi-Rel HXTR-5102	3-134
HXTR-5103	Linear Power Transistor (2N6741)	3-84
HXTR-5103TXV	Hi-Rel HXTR-5103	3-134
HXTR-5104	Linear Power Transistor	3-87
HXTR-5104TXV	Hi-Rel HXTR-5104	3-134

MODEL NO.	DESCRIPTION	PAGE NO.
HXTR-6001	Low Noise Transistor Chip	3-24
HXTR-6101	Low Noise Transistor (2N6617)	3-90
HXTR-6101TXV	Hi-Rel HXTR-6101	3-139
HXTR-6102	Low Noise Transistor (2N6742)	3-93
HXTR-6102TXV	Hi-Rel HXTR-6102	3-139
HXTR-6103	Low Noise Transistor (2N6618)	3-96
HXTR-6103TXV	Hi-Rel HXTR-6103	3-139
HXTR-6104	Low Noise Transistor (2N6743)	3-99
HXTR-6104TXV	Hi-Rel HXTR-6104	3-139
HXTR-6105	General Purpose Transistor	3-102
HXTR-6105TXV	Hi-Rel HXTR-6105	3-112
HXTR-6106	General Purpose Transistor	3-105
HXTR-6106TXV	Hi-Rel HXTR-6106	3-112
HXTR-7011	Low Noise Transistor Chip	3-26
HXTR-7111	Low Noise High Performance Transistor	3-108
HXTR-7111TXV	Hi-Rel HXTR-7111	3-143
2N6617TXV	Hi-Rel 2N6617	3-139
2N6618TXV	Hi-Rel 2N6618	3-139
2N6679TXV	Hi-Rel 2N6679	3-112
2N6701TXV	Hi-Rel 2N6701	3-134
2N6741TXV	Hi-Rel 2N6741	3-134
2N6742TXV	Hi-Rel 2N6742	3-139
2N6743TXV	Hi-Rel 2N6743	3-139
2N6838TXV	Hi-Rel 2N6838	3-116
2N6839TXV	Hi-Rel 2N6839	3-120

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR CHIP

HXTR-2001

Features

HIGH GAIN
17.5 dB Typical at 2 GHz

HIGH OUTPUT POWER
20.0 dBm P_{1dB} Typical at 2 GHz

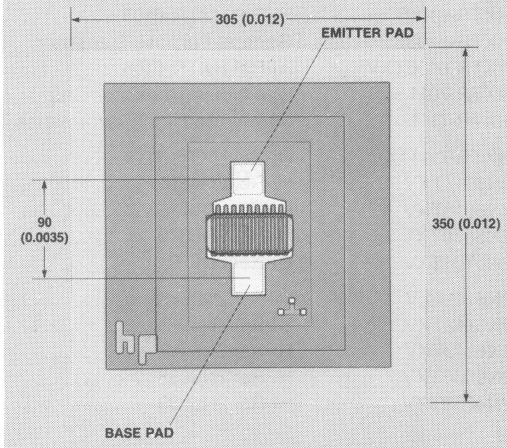
LOW NOISE FIGURE
3.8 dB Typical at 4 GHz

WIDE DYNAMIC RANGE

Description/Applications

The HXTR-2001 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-2001 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-2001 also is provided with a dielectric scratch protection over its active area.



Chip Outline

Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Dimensions:	25 (0.001) x 25 (0.001) Typical
Chip Thickness:	89 (0.0035) Typical
Collector Back Contact:	Silicon-Gold Eutectic

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	200°C
T_{STG}	Storage Temperature	-65°C to 300°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 65°C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10°C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer or collet and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10°C, using a tip force of 30 ± 5 grams with 0.7 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at $T_A = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at I_C=100μA		3011*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=15V		3041**	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB}=15V		3036**	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=15V, I_C=15mA		3076*	—	50	100	220
MAG	Maximum Available Gain	f=2GHz		dB		17.5	
	V_{CC} = 15V, I_C = 25 mA	4GHz				11.5	
P_{1dB}	Power Output at 1dB Gain Compression	f=2GHz		dBm		20.0	
	V_{CE} = 15V, I_C = 25 mA	4GHz				18.5	
NF_{MIN}	Minimum Noise Figure	f=2GHz	3246	dB		2.3	
	V_{CE} = 15V, I_C = 15 mA	4GHz				4.0	
G_A	Associated Gain	f=2GHz		dB		13.0	
	V_{CE} = 15 V, I_C = 15 mA	4GHz				9.0	

*300μs wide pulse measurement <2% duty cycle. **Measured under low ambient light conditions.

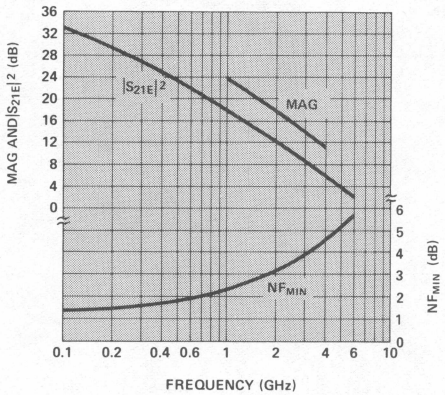


Figure 1. Typical MAG, $|S_{21E}|^2$, and Noise Figure (NF_{MIN}) vs. Frequency at V_{CE} = 15 V, I_C = 25 mA.

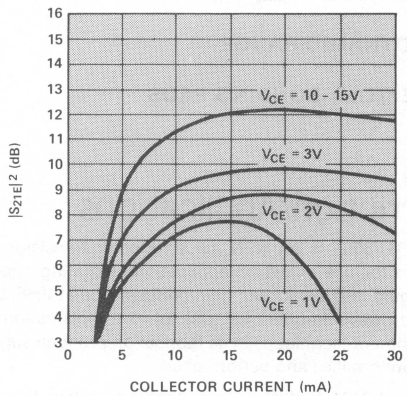


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 2 GHz.

Typical S-Parameters* V_{CE} = 15V, I_C = 25mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.57	-88	33.3	46.2	144	-42	0.008	58	0.85	-20
200	0.68	-124	30.2	32.5	123	-39	0.011	43	0.67	-26
300	0.72	-141	27.6	23.9	113	-38	0.013	37	0.56	-26
400	0.74	-150	25.4	18.7	106	-37	0.014	35	0.51	-24
500	0.75	-156	23.7	15.3	102	-37	0.014	35	0.48	-22
600	0.76	-160	22.2	12.9	99	-36	0.015	36	0.46	-21
700	0.76	-163	20.8	11.0	97	-36	0.015	37	0.45	-20
800	0.76	-165	19.9	9.8	95	-36	0.016	38	0.44	-19
900	0.76	-167	18.8	8.7	93	-36	0.016	40	0.44	-18
1000	0.76	-168	18.0	7.9	91	-35	0.017	42	0.44	-18
1500	0.77	-172	14.5	5.3	85	-34	0.021	49	0.43	-18
2000	0.77	-175	12.0	4.0	81	-32	0.025	54	0.43	-20
2500	0.77	-176	10.1	3.2	77	-31	0.029	58	0.43	-23
3000	0.77	-177	8.6	2.7	73	-29	0.034	60	0.43	-26
3500	0.77	-178	7.2	2.3	69	-28	0.038	61	0.44	-29
4000	0.76	-179	6.0	2.0	66	-27	0.043	62	0.44	-32
4500	0.76	-179	5.1	1.8	63	-26	0.048	62	0.45	-35
5000	0.76	-179	4.1	1.6	59	-26	0.052	62	0.45	-38
5500	0.76	-180	3.5	1.5	56	-25	0.057	62	0.46	-41
6000	0.76	-180	2.9	1.4	53	-24	0.062	61	0.47	-44

*Values do not include any parasitic bonding inductances and were generated by use of a computer model.

RF Equivalent Circuit See page 3-30.

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR CHIP

HXTR-3001

Features

HIGH GAIN
16 dB Typical at 2 GHz

HIGH OUTPUT POWER
21.0 dBm P_{1dB} Typical at 1 GHz

LOW NOISE FIGURE
1.5 dB Typical NF_{MIN} at 1000 MHz

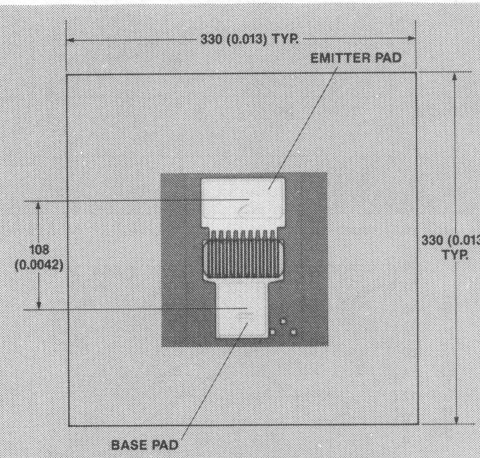
WIDE DYNAMIC RANGE

LARGE GOLD BONDING PADS

Description/Applications

The HXTR-3001 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-3001 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The chip is protected by silicon nitride passivation, and is provided with large gold bonding pads for ease of use in most hybrid applications.



Chip Outline

Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Typical Dimensions	
Base:	50 (0.002) x 50 (0.002)
Emitter:	75 (0.003) x 38 (0.0015)
Chip Thickness:	89 (0.0035) Typical
Collector Back Contact:	Silicon-Gold Eutectic

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	200°C
T_{STG}	Storage Temperature	-65°C to 300°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 65°C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10°C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer or collet and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10°C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at $T_A = 25°C$

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at I_C = 100μA	3011*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE} = 15V	3041**	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB} = 15V	3036**	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 15V, I_C = 15mA	3076*	—	50	100	220
MAG	Maximum Available Gain f = 2000 MHz V_{CE}=15V, I_C=15 mA		dB		16.0	
P_{1dB}	Power Output at 1 dB Gain Compression f = 1000 MHz 2000 MHz V_{CE}=15V, I_C=25 mA		dBm		21.0 19.0	
NF_{MIN}	Minimum Noise Figure f = 500 MHz 1000 MHz 2000 MHz V_{CE}=10V, I_C=7 mA	3246	dB		1.2 1.5 2.2	

*300μs wide pulse measurement <2% duty cycle.
**Measured under low ambient light conditions.

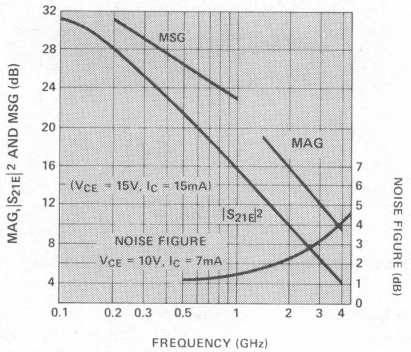


Figure 1. Typical MAG, $|S_{21E}|^2$, Maximum Stable Gain (MSG), and Noise Figure (NF_{MIN}) vs. Frequency.

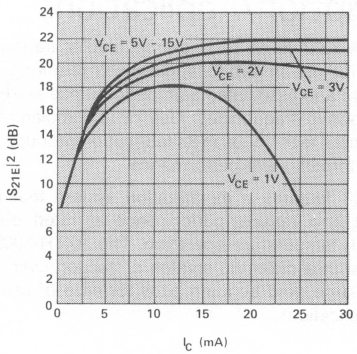


Figure 2. Typical $|S_{21E}|^2$ vs. Current of 500 MHz.

Typical S-Parameters* V_{CE} = 15V, I_C = 15 mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.651	-74	30.6	34.04	146	-37.2	0.014	59	0.851	-23
200	0.714	-113	27.8	24.66	125	-33.9	0.020	43	0.659	-33
300	0.741	-132	25.3	18.41	114	-32.9	0.023	36	0.539	-36
400	0.754	-143	23.2	14.46	107	-32.3	0.024	33	0.471	-36
500	0.761	-151	21.5	11.84	102	-32.0	0.025	31	0.429	-35
600	0.765	-155	20.0	10.00	98	-31.7	0.026	32	0.405	-34
700	0.767	-159	18.7	8.63	95	-31.5	0.027	32	0.389	-34
800	0.768	-162	17.6	7.59	93	-31.2	0.028	33	0.377	-34
900	0.769	-164	16.6	6.77	91	-31.0	0.028	34	0.370	-34
1000	0.770	-166	15.7	6.11	89	-30.7	0.029	35	0.365	-34
1500	0.770	-171	12.2	4.10	81	-29.3	0.034	41	0.358	-38
2000	0.769	-174	9.8	3.06	74	-28.0	0.040	44	0.364	-43
2500	0.766	-176	7.8	2.46	69	-26.8	0.046	47	0.375	-49
3000	0.763	-177	6.2	2.05	63	-25.7	0.052	48	0.389	-55
3500	0.760	-178	4.9	1.75	58	-24.7	0.058	48	0.405	-61
4000	0.756	-179	3.7	1.53	53	-23.8	0.064	48	0.423	-66

*Values do not include any parasitic bonding inductances and were generated by use of a computer model.

RF Equivalent Circuit See page 3-30.

HEWLETT PACKARD

LINEAR POWER TRANSISTOR CHIP

HXTR-3002

Features

HIGH OUTPUT POWER
22 dBm Typical P_{1dB} at 1 GHz

HIGH P_{1dB} GAIN
18.0 dB Typical G_{1dB} at 1 GHz

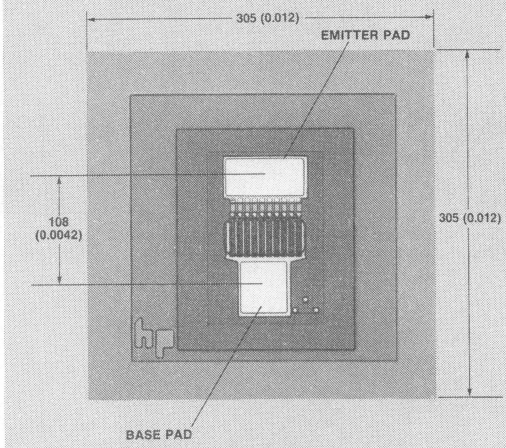
HIGH $|S_{21E}|^2$ GAIN
16.5 dB Typical at 500 MHz

LARGE GOLD BONDING PADS

Description/Applications

The HXTR-3002 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

HXTR-3002 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-3002 also is provided with a dielectric scratch protection over its active area and large gold bonding pads for ease of use in most hybrid applications.



Chip Outline

Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Typical Dimensions	
Base:	50 (0.002) x 50 (0.002)
Emitter:	75 (0.003) x 38 (0.0015)
Chip Thickness:	89 (0.0035) Typical
Collector Back Contact:	Silicon-Gold Eutectic

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4.0V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	1.4W
T_J	Junction Temperature	200°C
T_{STG}	Storage Temperature	-65°C to 300°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 70°C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10°C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer or collet and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10°C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at $T_A = 25°C$

Symbol	Parameters and Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 3 mA	3001*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C = 15 mA	3011*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B = 30 μA	3026*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB} = 2 V	3061*	μA			2
I_{CES}	Collector-Emitter Leakage Current at V_{CE} = 32 V	3041**	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB} = 20 V	3036**	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 18 V, I_C = 30 mA	3076*		15	40	75
P_{1dB}	Power Output at 1 dB Gain Compression f = 1000 MHz		dBm		22.0	
G_{1dB}	Associated 1 dB Compressed Gain f = 1000 MHz V_{CE} = 18 V, I_C = 30 mA		dB		18.0	
$\|S_{21E}\|^2$	Transducer Gain f = 500 MHz V_{CE} = 18 V, I_C = 30 mA 1000 MHz		dB		16.5 13.6	

*300 μs wide pulse measurement at ≤2% duty cycle.
**Measured under low ambient light conditions.

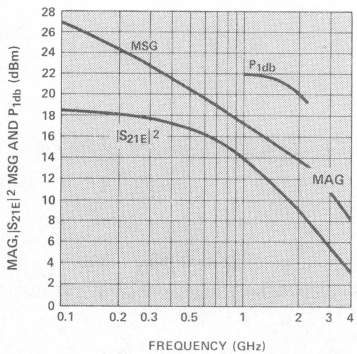


Figure 1. Typical MAG, $|S_{21E}|^2$, Maximum Stable Gain (MSG) and Power Output at 1 dB Gain Compression (P_{1dB}) vs. Frequency, V_{CE} = 18 V, I_C = 30 mA.

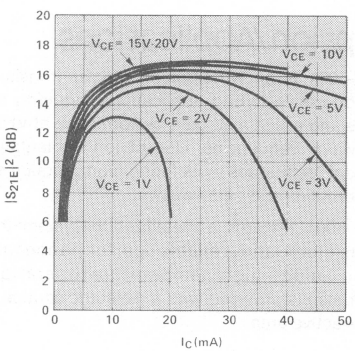


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 500 MHz.

Typical S-Parameters* V_{CE} = 18V, I_C = 30 mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.658	-17	18.5	8.44	170	-35.9	0.016	82	0.991	-7
200	0.656	-32	18.3	8.18	161	-30.1	0.031	75	0.965	-14
300	0.652	-47	17.8	7.79	153	-27.0	0.045	68	0.926	-20
400	0.648	-60	17.3	7.33	145	-25.0	0.056	62	0.881	-25
500	0.644	-72	16.7	6.85	138	-23.7	0.066	56	0.833	-29
600	0.641	-82	16.1	6.37	132	-22.7	0.073	52	0.787	-33
700	0.637	-91	15.4	5.91	126	-22.0	0.080	48	0.744	-36
800	0.634	-99	14.8	5.49	121	-21.5	0.085	45	0.706	-39
900	0.632	-105	14.2	5.11	117	-21.0	0.089	42	0.671	-41
1000	0.629	-111	13.6	4.76	113	-20.7	0.092	39	0.641	-43
1500	0.623	-131	10.9	3.50	98	-19.7	0.103	32	0.541	-50
2000	0.618	-143	8.8	2.74	88	-19.2	0.110	29	0.492	-54
2500	0.614	-151	7.0	2.24	79	-18.8	0.115	28	0.469	-58
3000	0.611	-156	5.6	1.90	72	-18.4	0.120	27	0.461	-62
3500	0.608	-160	4.3	1.65	65	-18.1	0.125	27	0.460	-66
4000	0.604	-163	3.3	1.46	59	-17.7	0.130	27	0.465	-70

Values do not include any parasitic bonding inductances and were generated by use of a computer model.

RF Equivalent Circuit See page 3-30.

HEWLETT PACKARD

LINEAR POWER TRANSISTOR CHIP

HXTR-5001

Features

HIGH OUTPUT POWER
- **23 dBm Typical P_{1dB} at 2 GHz**
- **22 dBm Typical P_{1dB} at 4 GHz**

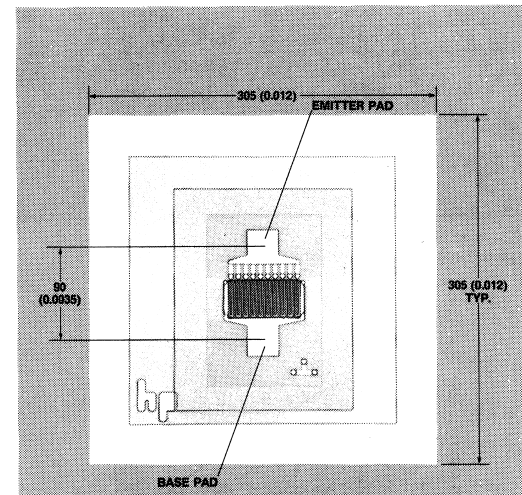
HIGH P_{1dB} GAIN
- **13.5 dB Typical G_{1dB} at 2 GHz**
- **8.0 dB Typical G_{1dB} at 4 GHz**

HIGH POWER-ADDED EFFICIENCY

Description/Applications

The HXTR-5001 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-5001 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-5001 also is provided with a dielectric scratch protection over its active area.



Chip Outline

Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Dimensions: 25 (0.001) x 25 (0.001)
Chip Thickness: 89 (0.0035) Typical
Collector Back Contact: Silicon-Gold Eutectic

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4.0V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	1.4W
T_J	Junction Temperature	200°C
T_{STG}	Storage Temperature	-65°C to 300°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 70°C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10° C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer or collet and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10°C, using a tip force of 30 ± 5 grams with 0.7 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at T_A=25°C

Symbol	Parameters and Test Condtiions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 3 mA	3001*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C = 15 mA	3011*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B = 30 μA	3026*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB} = 2 V	3061	μA			2
I_{CES}	Collector-Emitter Leakage Current at V_{CE} = 32 V	3041**	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB} = 20 V	3036**	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 18 V, I_C = 30 mA	3076*		15	35	75
P_{1dB}	Power Output at 1 dB Gain Compression f = 2 GHz 4 GHz		dBm		23.0 22.0	
G_{1dB}	Associated 1 dB Compressed Gain f = 2 GHz 4 GHz		dB		13.5 7.5	
P_{SAT}	Saturated Power Output (8 dB Gain) f = 2 GHz (3 dB Gain) 4 GHz		dBm		25.5 25.0	
η	Power-Added Efficiency at 1 dB Compression f = 2 GHz 4 GHz		%		35 25	
IP_3	Third Order Intercept Point f = 4 GHz V_{CE} = 18 V, I_C = 30 mA		dBm		32	

*300 μs wide pulse measurement at ≤2% duty cycle.
**Measured under low ambient light conditions.

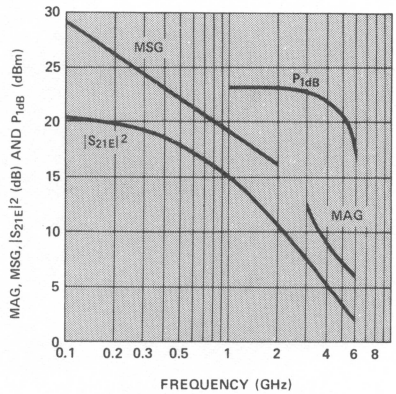


Figure 1. Typical MAG, Maximum Stable Gain (MSG), $|S_{21E}|^2$ and P_{1dB} Linear Power vs. Frequency at V_{CE} = 18 V, I_C = 30 mA.

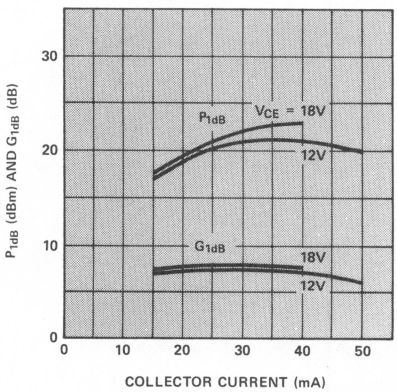


Figure 2. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Current at V_{CE} = 12 V and 18 V at 4 GHz.

Typical S-Parameters* V_{CE} = 18V, I_C = 30 mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (GHz)	Mag.	Ang.	dB	Mag.	Ang.	dB	Mag.	Ang.	Mag.	Ang.
0.100	0.74	-15	20.2	10.2	171	-38	0.01	83	0.99	-5
0.200	0.73	-30	19.9	9.88	162	-33	0.02	75	0.97	-10
0.300	0.72	-44	19.5	9.42	154	-30	0.03	69	0.93	-15
0.400	0.71	-57	19.0	8.87	146	-28	0.04	63	0.89	-19
0.500	0.70	-68	18.4	8.28	140	-26	0.05	58	0.85	-22
0.600	0.69	-78	17.7	7.71	134	-25	0.06	54	0.80	-24
0.700	0.67	-87	17.1	7.16	129	-25	0.06	50	0.76	-26
0.800	0.67	-94	16.5	6.65	124	-24	0.06	47	0.73	-28
0.900	0.66	-101	15.8	6.19	120	-24	0.07	44	0.70	-29
1.000	0.65	-107	15.2	5.78	117	-23	0.07	42	0.67	-30
1.500	0.63	-128	12.6	4.25	103	-22	0.08	37	0.58	-32
2.000	0.62	-140	10.5	3.33	94	-22	0.08	35	0.53	-32
2.500	0.61	-148	8.7	2.73	87	-21	0.09	35	0.51	-33
3.000	0.61	-154	7.3	2.32	81	-21	0.09	35	0.50	-35
3.500	0.61	-158	6.1	2.02	76	-20	0.10	36	0.49	-36
4.000	0.60	-161	5.8	1.79	71	-20	0.10	37	0.49	-38
4.500	0.60	-164	4.1	1.61	66	-19	0.11	38	0.49	-40
5.000	0.60	-166	3.3	1.47	62	-19	0.11	39	0.49	-43
5.500	0.59	-168	2.6	1.35	58	-19	0.12	40	0.49	-45
6.000	0.59	-169	2.0	1.25	55	-18	0.12	40	0.49	-47

*Values do not include any parasitic bonding inductances and were generated by use of a computer model.

RF Equivalent Circuit See page 3-30.

HEWLETT PACKARD

LINEAR POWER TRANSISTOR CHIP

HXTR-5002

Features

HIGH OUTPUT POWER
- **29 dBm Typical P_{1dB} at 2 GHz**
- **27.5 dBm Typical P_{1dB} at 4 GHz**

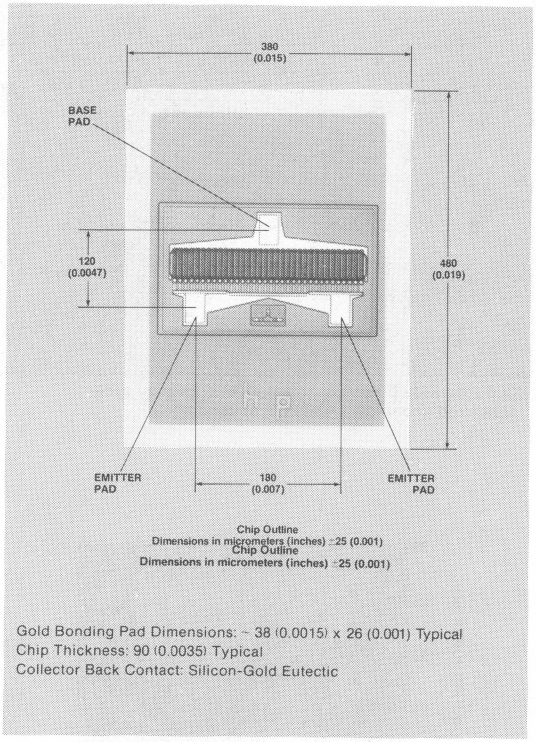
HIGH P_{1dB} GAIN
- **12.5 dB Typical G_{1dB} at 2 GHz**
- **7.5 dB Typical G_{1dB} at 4 GHz**

HIGH POWER-ADDED EFFICIENCY

Description/Applications

The HXTR-5002 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-5002 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-5002 also is provided with a dielectric scratch protection over its active area, and Ta_2N ballast resistors for ruggedness.



Chip Outline
Dimensions in micrometers (inches) ±25 (0.001)

Gold Bonding Pad Dimensions: ~ 38 (0.0015) x 26 (0.001) Typical
Chip Thickness: 90 (0.0035) Typical
Collector Back Contact: Silicon-Gold Eutectic

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4V
I_C	DC Collector Current	250 mA
P_T	Total Device Dissipation	4W
T_J	Junction Temperature	200°C
T_{STG}	Storage Temperature	-65°C to 300°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 35°C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10°C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer or collet and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10°C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at T_A=25°C

Symbol	Parameters and Test Condtiions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C=10mA	3001*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C=50mA	3011*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B=100μA	3026*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB}=2V	3061	μA			5
I_{CES}	Collector-Emitter Leakage Current at V_{CE}=32V	3041**	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB}=20V	3036**	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=18V, I_C=110mA	3076*		15	40	75
P_{1dB}	Power Output at 1dB Gain Compression f = 2GHz 4GHz		dBm		29.0 27.5	
G_{1dB}	Associated 1dB Compressed Gain f = 2GHz 4GHz		dB		11.5 7.5	
P_{SAT}	Saturated Power Output (8dB Gain) f = 2GHz (3dB Gain) 4GHz		dBm		31.0 29.5	
η	Power-Added Efficiency at 1dB Compression f = 2GHz 4GHz		%		38 23	
IP_3	Third Order Intercept Point f = 4GHz V_{CE}=18V, I_C=110mA		dBm		37	

*300 μsec wide pulse measurement at ≤ 2% duty cycle.
**Measured under low ambient light conditions.

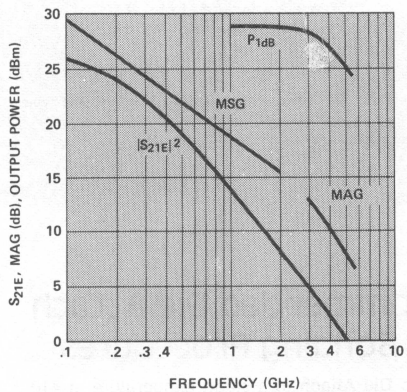


Figure 1. Typical $|S_{21E}|^2$ MAG and P_{1dB} Linear Power vs. Frequency at V_{CE} = 18 V, I_C = 110 mA.

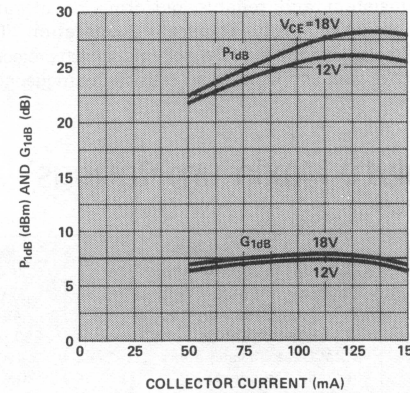


Figure 2. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Current at V_{CE} = 12 and 18 V at 4 GHz.

Typical S-Parameters* V_{CE} = 18V, I_C = 110mA

Freq. (GHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
0.100	0.55	-61	25.4	19.7	156	-31.6	0.03	68	0.93	-26
0.200	0.65	-98	24.2	16.2	133	-27.3	0.04	50	0.76	-46
0.300	0.72	-119	22.3	13.1	125	-25.6	0.05	39	0.63	-60
0.400	0.76	-132	20.6	10.7	117	-24.8	0.06	32	0.53	-71
0.500	0.79	-141	19.1	9.01	111	-24.4	0.06	27	0.45	-78
0.600	0.80	-147	17.8	7.73	106	-24.1	0.06	24	0.40	-84
0.700	0.81	-151	16.6	6.74	102	-24.0	0.06	22	0.36	-89
0.800	0.81	-155	15.5	5.97	99	-23.8	0.06	20	0.33	-93
0.900	0.82	-158	14.6	5.35	97	-23.7	0.06	19	0.31	-96
1.000	0.82	-160	13.7	4.84	94	-23.7	0.06	18	0.30	-99
1.500	0.83	-167	10.3	3.29	86	-23.4	0.07	16	0.25	-109
2.000	0.83	-170	7.9	2.49	80	-23.3	0.07	16	0.24	-114
2.500	0.83	-173	6.0	2.00	74	-23.1	0.07	17	0.24	-117
3.000	0.83	-174	4.5	1.68	69	-22.9	0.07	18	0.25	-118
3.500	0.83	-175	3.2	1.44	64	-22.6	0.07	19	0.27	-119
4.000	0.83	-176	2.1	1.27	60	-22.4	0.08	20	0.28	-120
4.500	0.83	-177	1.1	1.13	55	-22.1	0.08	21	0.30	-121
5.000	0.83	-177	0.3	1.03	51	-21.9	0.08	21	0.32	-121
5.500	0.83	-178	-0.5	0.94	47	-21.6	0.08	22	0.34	-122
6.000	0.83	-178	-1.2	0.87	43	-21.4	0.08	22	0.35	-123

*(Values do not include any parasitic bonding inductances and were generated by use of a computer model.)

RF Equivalent Circuit See page 3-30.

HEWLETT PACKARD

LOW NOISE TRANSISTOR CHIP

HXTR-6001

Features

LOW NOISE FIGURE

- **1.7 dB Typical NF_{MIN} at 2 GHz**
- **2.7 dB Typical NF_{MIN} at 4 GHz**

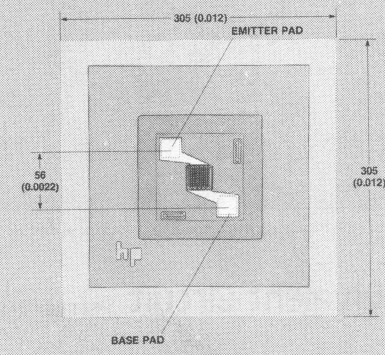
HIGH ASSOCIATED GAIN

- **13.0 dB Typical G_A at 2 GHz**
- **9.0 dB Typical G_A at 4 GHz**

Description/Applications

The HXTR-6001 is an NPN silicon bipolar transistor chip designed for use in hybrid applicattons requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-6001 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The HXTR-6001 also is provided with a dielectric scratch protection over its active area.



Chip Outline

Dimensions in Micrometers (Inches) ± 25 (0.001)

Gold Bonding Pad Dimensions:	25 (0.001) x 25 (0.001) Typical
Chip Thickness:	89 (0.0035) Typical
Collector Back Contact:	Silicon-Gold Eutectic

Absolute Maximum Ratings*

($T_A = 25°C$)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	35V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	20 mA
P_T	Total Device Dissipation	300 mW
T_J	Junction Temperature	200°C
T_{STG}	Storage Temperature	-65°C to 300°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:

1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 100 °C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10°C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer or collet and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ' 10°C, using a tip force of 30 ' 5 grams with 0.7 mil gold wire. A one mil minimium wire clearance at the passivation edge is recommended. (Ultasonic bonding is not recommended.)

Electrical Specifications at $T_A = 25°C$

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at I_C=100μA		3011 *	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=10V		3041 **	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB}=10V		3036 **	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=10V, I_C=4mA		3076 *	—	50	100	250
NF_{MIN}	Minimum Noise Figure	f=2 GHz 4 GHz	3246	dB		1.7 2.7	
G_A	Associated Gain V_{CE}=10V, I_C=4mA	f=2 GHz 4 GHz	3246	dB		13.0 9.0	

*300μs wide pulse measurement ≤2% duty cycle.
**Measured under low ambient light conditions.

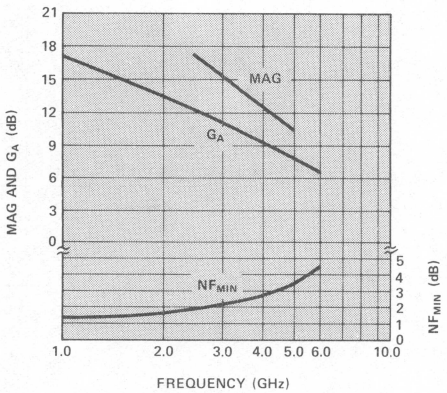


Figure 1. Typical MAG, Noise Figure (NF_{MIN}), and Assoicated Gain vs. Frequency at V_{CE} = 10 V, I_C = 4 mA.

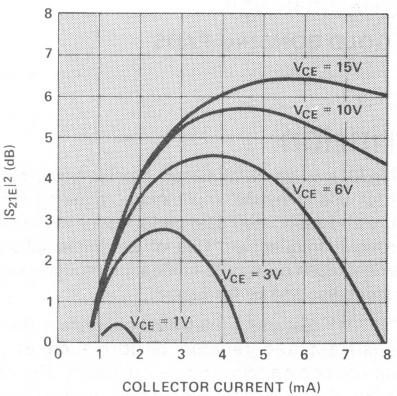


Figure 2. Typical $|S_{21E}|^2$, vs. Current at 4 GHz.

Typical S-Parameters* V_{CE} = 10V, I_C = 4mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.87	-16	22.0	12.60	170	-46	0.005	82	0.99	-3
200	0.85	-30	21.7	12.10	160	-40	0.010	75	0.98	-5
300	0.82	-44	21.1	11.40	151	-36	0.015	68	0.95	-7
400	0.79	-57	20.5	10.60	144	-35	0.018	63	0.93	-9
500	0.76	-68	19.8	9.77	137	-34	0.021	58	0.91	-10
600	0.73	-78	19.1	9.00	131	-32	0.024	55	0.89	-10
700	0.70	-86	18.5	8.37	126	-32	0.025	52	0.87	-11
800	0.68	-94	17.6	7.62	121	-31	0.027	50	0.85	-11
900	0.66	-100	17.0	7.05	118	-31	0.028	48	0.84	-11
1000	0.65	-106	16.3	6.54	114	-31	0.029	47	0.82	-11
1500	0.60	-126	13.5	4.73	102	-29	0.034	45	0.79	-12
2000	0.58	-139	11.3	3.67	93	-29	0.037	45	0.78	-13
2500	0.57	-146	9.5	2.99	87	-28	0.041	47	0.77	-14
3000	0.56	-152	8.1	2.53	82	-27	0.045	49	0.77	-15
3500	0.56	-156	6.8	2.19	77	-26	0.049	51	0.76	-16
4000	0.55	-159	5.7	1.93	72	-26	0.053	52	0.76	-18
4500	0.55	-162	4.8	1.73	68	-25	0.057	53	0.76	-19
5000	0.55	-164	3.9	1.57	65	-24	0.062	54	0.76	-21
5500	0.55	-165	3.2	1.44	61	-24	0.066	55	0.76	-23
6000	0.54	-167	2.5	1.34	57	-23	0.071	55	0.76	-24
7000	0.54	-169	1.4	1.17	51	-22	0.080	56	0.77	-28

*Values do not include any parasitic bonding inductances and were generated by use of a computer model.

RF Equivalent Circuit See page 3-30.

HEWLETT PACKARD

LOW NOISE TRANSISTOR CHIP

HXTR-7011

Features

LOW NOISE FIGURE
2.8 dB Typical NF_{MIN} at 4 GHz

HIGH ASSOCIATED GAIN
8 dB Typical G_A at 4 GHz

HIGH OUTPUT POWER
18.0 dBm Typical P_{1dB} at 4 GHz

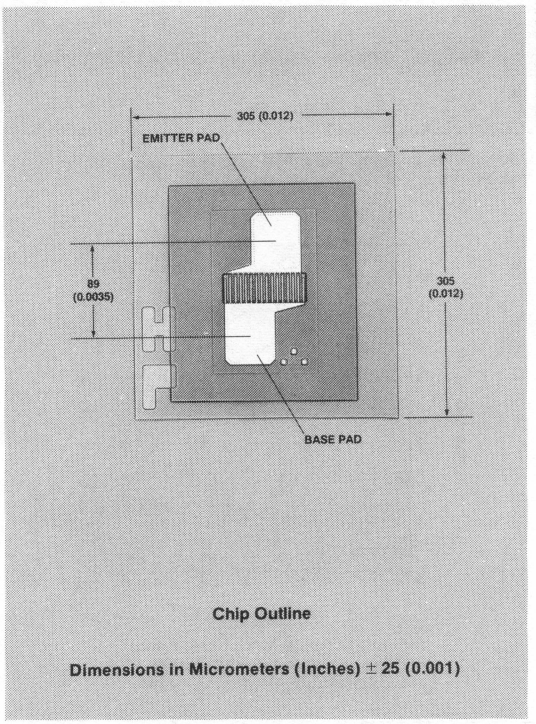
WIDE DYNAMIC RANGE

LARGE GOLD BONDING PADS

Description

The HXTR-7011 is an NPN silicon bipolar transistor chip designed for use in hybrid applications requiring superior noise figure and associated gain performance at VHF, UHF, and microwave frequencies. Use of ion implantation and self alignment techniques in its fabrication produce superior device uniformities and performance.

The HXTR-7011 features a metallization system that provides consistent and reliable performance at rated dissipation under high temperature operation. The chip is protected by silicon nitride passivation, and is provided with large gold bonding pads for ease of use in most hybrid applications.



Chip Outline

Dimensions in Micrometers (Inches) ± 25 (0.001)

Absolute Maximum Ratings*

(T_A = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	−65° C to 300° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. Power dissipation derating should include a Θ_{JB} (Junction-to-Back contact thermal resistance) of 60 °C/W. Total Θ_{JA} (Junction-to-Ambient) will be dependent upon the heat sinking provided in the individual application.

Gold Bonding Pad Dimensions (Typical):	40 (0.0016) x 48 (0.0019)
Chip Thickness (Typical):	89 (0.0035)
Collector Back Contact:	Silicon-Gold Eutectic

Recommended Die Attach and Bonding Procedures

Eutectic Die Attach at a stage temperature of 410 ± 10° C under an N_2 ambient. Chip should be lightly scrubbed using a tweezer or collet and eutectic should flow within five seconds.

Thermocompression Wire Bond at a stage temperature of 310 ± 10° C, using a tip force of 30 ± 5 grams with 0.7 or 1.0 mil gold wire. A one mil minimum wire clearance at the passivation edge is recommended. (Ultrasonic bonding is not recommended.)

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$	3001*	V	30		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA	3011*	V	18		
I_{CBO}	Collector-Base Cutoff Current at $V_{CE} = 15$ V	3041	nA			50
I_{CEO}	Collector-Emitter Leakage at $V_{CE} = 15$ V	3036**	nA			50
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA	3076*		55		175
NF_{MIN}	Minimum Noise Figure $V_{CE} = 10$ V, $I_C = 10$ mA f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246	dB		1.2 1.7 2.8	
G_A	Associated Gain $V_{CE} = 10$ V, $I_C = 10$ mA f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246	dB		1.4 1.9 3.0	
P_{1dB}	Power Output at 1 dB Gain Compression, $V_{CE} = 15$ V, $I_C = 18$ mA, f = 4000 MHz		dBm		18.0	
G_{1dB}	Associated 1 dB Compressed Gain, $V_{CE} = 15$ V, $I_C = 18$ mA f = 4000 MHz		dB		8.5	

*300 μs wide pulse measurement $\leq$ 2% duty cycle.
**Measured under low ambient light conditions.

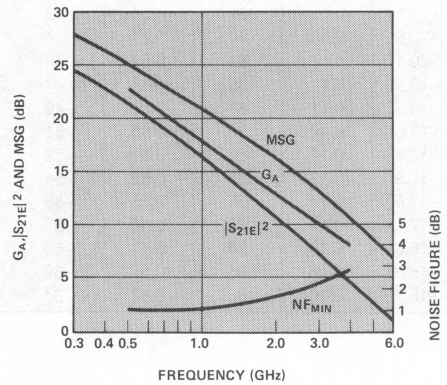


Figure 1. Typical NF_{MIN}, G_A $|S_{21E}|^2$ and MSG vs. Frequency at $V_{CE} = 10$ V, $I_C = 10$ mA.

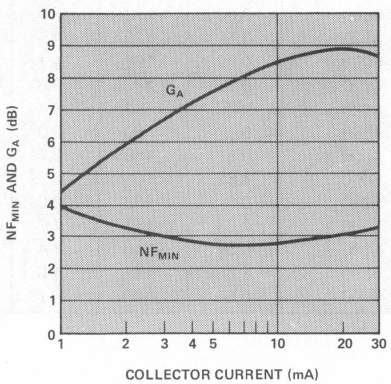


Figure 2. Typical NF_{MIN} and Associated Gain vs. I_C at 4 GHz for $V_{CE} = 10$ V.

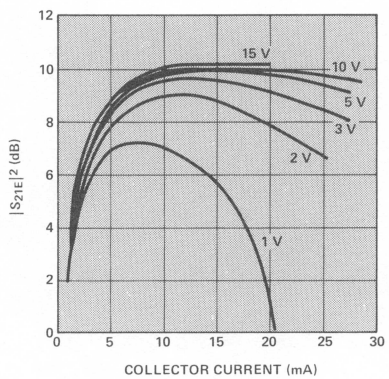


Figure 3. Typical $|S_{21E}|^2$ vs. Current at 2000 GHz.

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

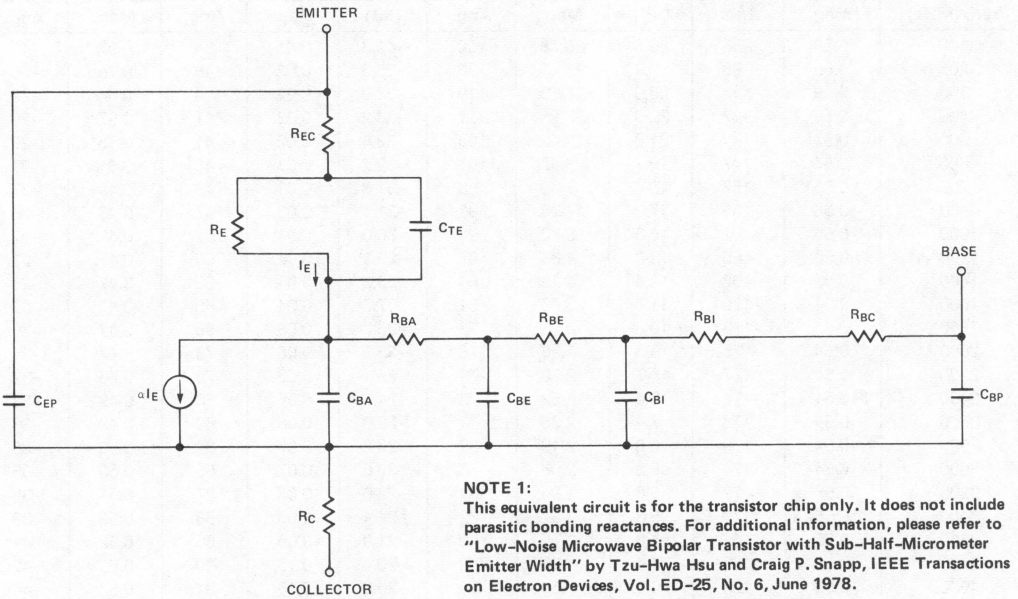
	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.70	-35	26.8	21.79	163	-38.8	0.01	70	0.96	-12
200	0.69	-68	25.5	18.75	144	-33.1	0.02	57	0.86	-21
300	0.67	-92	23.9	15.58	130	-31.0	0.03	49	0.75	-27
400	0.65	-109	22.2	12.90	120	-30.0	0.03	44	0.67	-29
500	0.64	-121	20.7	10.88	113	-29.3	0.03	40	0.62	-30
600	0.63	-130	19.4	9.31	108	-29.0	0.04	40	0.58	-30
700	0.62	-136	18.2	8.13	103	-28.3	0.04	40	0.55	-30
800	0.61	-141	17.1	7.17	100	-28.2	0.04	40	0.53	-30
1000	0.60	-149	15.2	5.77	94	-27.5	0.04	42	0.51	-30
1200	0.60	-155	13.7	5.87	90	-27.0	0.05	45	0.50	-31
1400	0.59	-159	12.5	4.20	86	-26.5	0.05	50	0.49	-31
1600	0.59	-162	11.3	3.69	83	-26.1	0.05	53	0.49	-32
1800	0.58	-165	10.4	3.31	80	-25.6	0.05	57	0.49	-33
2000	0.59	-168	9.6	3.01	78	-25.1	0.06	61	0.49	-34
2200	0.58	-171	8.8	2.75	75	-24.6	0.06	65	0.50	-35
2400	0.58	-173	8.1	2.54	73	-24.1	0.06	67	0.50	-35
2600	0.58	-175	7.5	2.37	72	-23.7	0.07	71	0.51	-36
2800	0.58	-177	6.9	2.22	69	-23.1	0.07	74	0.51	-37
3000	0.58	-180	6.4	2.08	67	-22.5	0.08	77	0.52	-38
3200	0.58	178	5.9	1.97	65	-22.0	0.08	79	0.52	-39
3400	0.58	175	5.4	1.86	62	-21.5	0.08	80	0.53	-41
3600	0.58	173	5.0	1.77	60	-21.1	0.09	82	0.54	-43
3800	0.59	170	4.5	1.69	58	-20.6	0.09	84	0.54	-44
4000	0.59	168	4.1	1.61	55	-20.1	0.10	84	0.54	-46
4200	0.59	165	3.8	1.54	53	-19.6	0.11	85	0.55	-47
4400	0.60	163	3.4	1.48	51	-19.1	0.11	86	0.55	-49
4600	0.60	160	3.0	1.42	49	-18.8	0.12	86	0.55	-51
4800	0.61	158	2.7	1.36	46	-18.3	0.12	86	0.55	-52
5000	0.62	156	2.3	1.30	44	-17.9	0.13	86	0.55	-54
5200	0.62	153	2.0	1.25	42	-17.5	0.13	86	0.55	-55
5400	0.63	151	1.7	1.21	40	-17.0	0.14	86	0.56	-57
5600	0.64	149	1.4	1.17	38	-16.5	0.15	86	0.57	-60
5800	0.65	147	1.0	1.13	36	-16.2	0.16	86	0.57	-62
6000	0.66	146	0.7	1.09	34	-15.7	0.16	86	0.57	-64

Typical S-Parameters (V_{CE} = 10 V, I_C = 20 mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.58	-56	29.8	30.78	156	-40.3	0.01	64	0.92	-16
200	0.60	-96	27.4	23.45	133	-35.6	0.02	48	0.75	-26
300	0.59	-118	25.0	17.73	119	-33.9	0.02	44	0.64	-29
400	0.58	-132	22.9	13.95	111	-33.2	0.02	41	0.57	-29
500	0.57	-141	21.2	11.42	105	-32.6	0.02	41	0.53	-28
600	0.57	-147	19.7	9.62	101	-32.2	0.03	43	0.51	-27
700	0.56	-152	18.4	8.30	98	-31.3	0.03	45	0.49	-27
800	0.56	-155	17.2	7.28	95	-31.1	0.03	47	0.48	-26
1000	0.55	-161	15.3	5.82	90	-30.0	0.03	52	0.47	-27
1200	0.55	-165	13.8	4.88	87	-29.1	0.04	56	0.47	-27
1400	0.55	-168	12.4	4.18	84	-28.2	0.04	62	0.47	-28
1600	0.54	-170	11.3	3.68	81	-27.5	0.04	65	0.47	-29
1800	0.54	-173	10.3	3.28	78	-26.7	0.05	68	0.47	-30
2000	0.54	-175	9.5	2.98	76	-25.9	0.05	73	0.47	-31
2200	0.54	-177	8.7	2.72	74	-25.1	0.06	76	0.48	-32
2400	0.54	-179	8.0	2.52	72	-24.6	0.06	78	0.49	-33
2600	0.54	178	7.4	2.35	71	-23.9	0.06	82	0.49	-33
2800	0.54	176	6.8	2.19	69	-23.2	0.07	84	0.50	-35
3000	0.54	174	6.3	2.06	66	-22.6	0.07	86	0.50	-36
3200	0.55	172	5.8	1.94	64	-22.0	0.08	87	0.51	-38
3400	0.55	170	5.3	1.84	62	-21.4	0.09	88	0.52	-39
3600	0.55	167	4.8	1.75	60	-21.0	0.09	89	0.52	-41
3800	0.55	165	4.4	1.66	58	-20.4	0.10	90	0.53	-42
4000	0.56	163	4.0	1.59	56	-20.0	0.10	91	0.53	-44
4200	0.57	160	3.6	1.52	53	-19.4	0.11	91	0.54	-46
4400	0.57	158	3.3	1.46	51	-19.0	0.11	91	0.54	-47
4600	0.58	156	2.9	1.40	49	-18.6	0.12	91	0.54	-49
4800	0.59	153	2.6	1.34	47	-18.1	0.12	91	0.54	-51
5000	0.60	151	2.2	1.29	45	-17.7	0.13	91	0.54	-52
5200	0.61	149	1.9	1.24	43	-17.3	0.14	91	0.54	-54
5400	0.62	147	1.6	1.20	41	-16.8	0.14	91	0.55	-55
5600	0.63	146	1.3	1.16	39	-16.4	0.15	90	0.56	-58
5800	0.64	144	1.0	1.12	38	-16.0	0.16	90	0.56	-60
6000	0.65	142	0.7	1.09	36	-15.5	0.17	90	0.56	-62

RF Equivalent Circuit See page 3-30.

SILICON BIPOLAR TRANSISTOR CHIP EQUIVALENT CIRCUITS[1]



NOTE 1:
This equivalent circuit is for the transistor chip only. It does not include parasitic bonding reactances. For additional information, please refer to "Low-Noise Microwave Bipolar Transistor with Sub-Half-Micrometer Emitter Width" by Tzu-Hwa Hsu and Craig P. Snapp, IEEE Transactions on Electron Devices, Vol. ED-25, No. 6, June 1978.

Current Dependent Current Source

$$\alpha = \frac{\alpha o}{1 + j\, f/f_b} \exp(-j\, 2\pi\, f\, \tau)$$

$$\alpha o = \frac{h_{FE}}{1 + h_{FE}}$$

$$Re\ \alpha = \frac{\alpha o}{1 + (f/f_b)^2} \left[\cos(2\pi\, f\tau) \frac{-f}{f_b} \sin(2\pi\, f\tau)\right]$$

$$Im\ \alpha = \frac{-\alpha o}{1 + (f/f_b)^2} \left[\sin 2\pi\, f\tau) \frac{+f}{f_b} \sin(2\pi\, f\tau)\right]$$

Bipolar Chip Equivalent Circuit Elements

Device	C_{BP} (pF)	C_{EP} (pF)	C_{BI} (pF)	C_{BE} (pF)	C_{BA} (pF)	C_{TE} (pF)	R_{EC} (Ω)	R_{BI} & R_{BC} (Ω)	R_{BE} (Ω)	R_{BA} (Ω)	R_C (Ω)	R_E (Ω)	$\alpha 0$	f_b GHz	τ psec.
HXTR-2001, 15 V, 25 mA	0.066	0.06	0.07	0.056	0.032	4.8	0.2	0.2	3.5	4.4	5	1.0	0.990	22.7	10.8
HXTR-2001, 15 V, 15 mA	0.066	0.06	0.07	0.056	0.032	4.8	0.2	0.2	3.5	4.4	5	1.7	0.990	22.7	10.6
HXTR-3001, 15 V, 15 mA	0.117	0.15	0.07	0.056	0.032	4.8	0.2	0.2	3.5	4.4	5	1.7	0.990	22.7	10.6
HXTR-3002, 18 V, 30 mA	0.117	0.19	0.07	0.053	1.034	5.1	7.2	0.2	5.6	4.7	5	0.86	0.976	22.7	10.8
HXTR-5001, 18 V, 30 mA	0.065	0.06	0.07	0.053	1.034	5.1	7.2	0.2	5.6	4.7	5	0.86	0.976	22.7	10.8
HXTR-5002, 18 V, 110 mA	0.105	0.15	0.22	0.18	0.11	17.3	3.1	0.2	1.7	1.4	3	0.24	0.976	22.7	10.9
HXTR-6001, 10 V, 4 mA	0.053	0.05	0.019	0.016	0.0055	1.03	0.7	0.4	7.8	6.1	7	6.5	0.990	22.7	12.1
HXTR-7011, 10 V, 10 mA	0.113	0.11	0.07	0.034	0.017	3.65	0.22	0.13	0.9	2.0	6	2.6	0.990	16.4	15.6

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR

2N6679
(HXTR-2101)

Features

HIGH GAIN

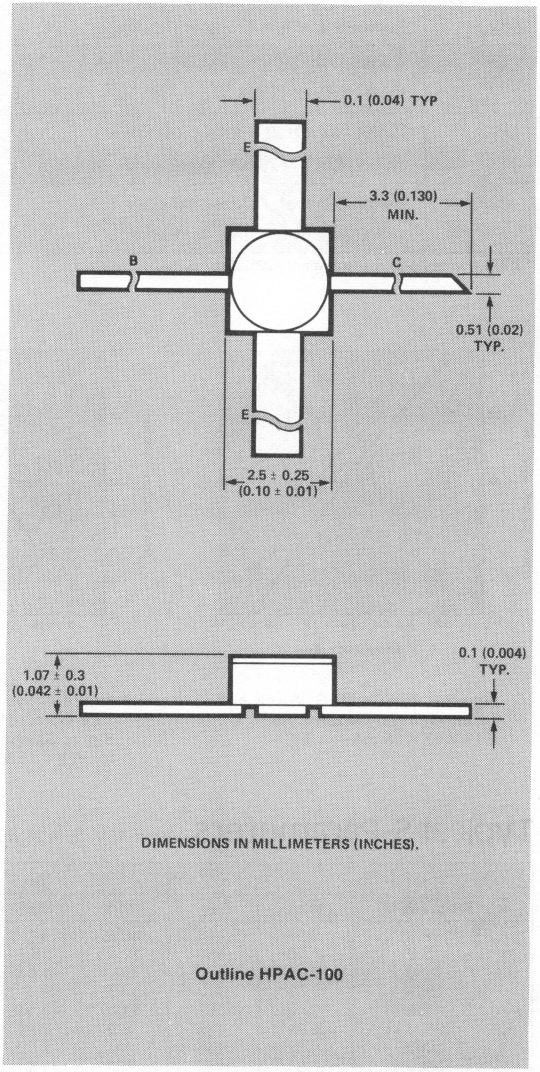
10.5 dB Typical at 4 GHz

HERMETIC PACKAGE

Description

The 2N6679 (HXTR-2101) is an NPN bipolar transistor designed for high gain and output power at 4 GHz. The device is manufactured using ion implantation and self alignment techniques. The chip is provided with a dielectric scratch protection over its active area.

The 2N6679 is supplied in the HPAC-100, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-100

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 125° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE}=25°C

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage I_C=100μA	3011*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=15V	3041	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB}=15V	3036	nA			100
h_{FE}	Forward Current Transfer Ratio V_{CE}=15V, I_C=15mA	3076*	–	50	100	220
G_T	Tuned Gain V_{CE} = 15V, I_C = 25 mA, Frequency = 4 GHz		dB	9.0	10	
P_{1dB}	Power Output at 1 dB Compression V_{CE}=15V, I_C=25mA, Frequency = 4 GHz		dBm		18.5	
C_{cb}	Reverse Transfer Capacitance I_C = 0 mA; V_{CB} = 10 V; f = 1 MHz		pF		0.27	

*300 μs wide pulse measurement ≤2% duty cycle.

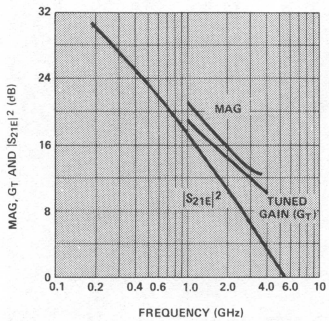


Figure 1. Typical MAG, $|S_{21E}|^2$ and Tuned Gain vs. Frequency at V_{CE} = 15 V, I_C = 25 mA.

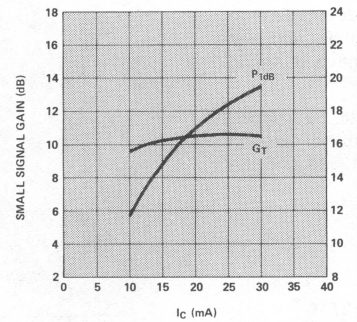


Figure 2. Typical Power Output at 1 dB Compression and Small Signal Gain vs. Collector at 4 GHz for V_{CE} = 15 V.

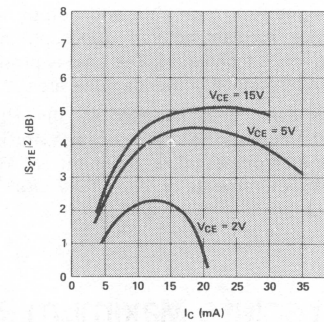


Figure 3. Typical $|S_{21E}|^2$ vs. Bias at 4 GHz.

Typical S-Parameters V_{CE} = 15V, I_C = 25 mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.59	-66	30.8	34.6	146	-40.0	0.01	69	0.86	-18
500	0.58	-150	22.1	12.7	96	-33.2	0.02	44	0.51	-27
1000	0.59	-175	16.7	6.86	78	-30.5	0.03	51	0.44	-32
1500	0.59	173	13.3	4.61	64	-28.0	0.04	55	0.45	-39
2000	0.60	162	11.0	3.53	53	-25.7	0.05	55	0.44	-49
2500	0.61	156	8.9	2.79	43	-24.2	0.06	55	0.47	-60
3000	0.62	146	7.3	2.32	33	-22.6	0.07	56	0.48	-67
3500	0.63	139	5.9	1.96	22	-21.2	0.09	53	0.52	-79
4000	0.62	131	4.8	1.73	11	-19.7	0.10	50	0.55	-84
4500	0.61	123	3.5	1.50	1	-18.8	0.12	48	0.59	-93
5000	0.60	116	2.6	1.35	-9	-17.0	0.14	44	0.65	-102
5500	0.62	109	1.8	1.23	-19	-15.9	0.16	36	0.66	-113
6000	0.62	103	0.9	1.11	-28	-15.6	0.17	32	0.66	-123
6500	0.62	93	0.0	1.02	-37	-13.7	0.20	28	0.67	-131

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR

HXTR-2102

Features

HIGH GAIN

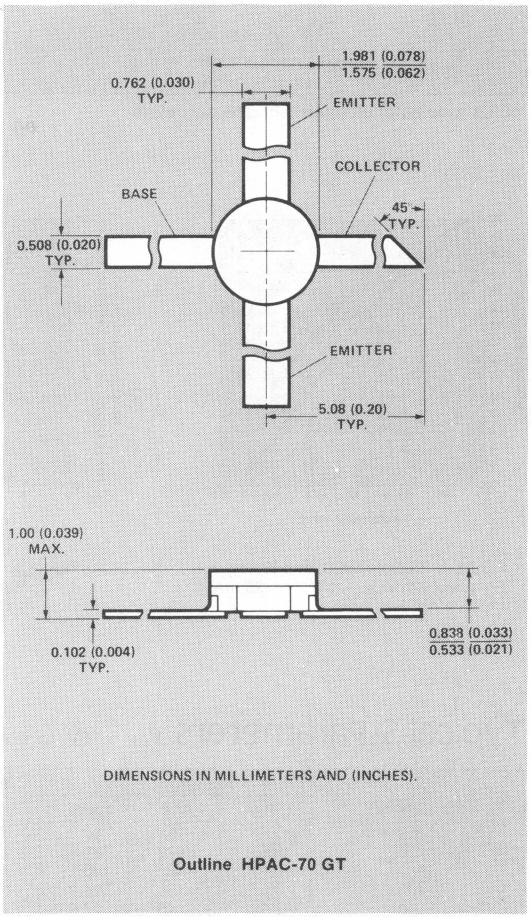
11 dB Typical at 4 GHz

HERMETIC PACKAGE

Description

The HXTR-2102 is an NPN bipolar transistor designed for high gain and wide dynamic range up to 6 GHz. The device is manufactured using ion implantation and self alignment techniques. The chip is provided with a dielectric scratch protection over its active area.

The HXTR-2102 is supplied in the HPAC-70GT, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-70 GT

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:

1. A Θ_{JC} maximum of 130° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE}=25°C

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at I_C = 100μA	3011*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE} = 15V	3041	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB} = 15V	3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 15V, I_C = 15mA	3076*	—	50	100	220
G_T	Tuned Gain f=2 GHz V_{CE} = 15V, I_C = 25mA 4 GHz		dB	13.0	15.0 10.5	
P_{1dB}	Power Output at 1 dB Compression f=2 GHz V_{CE} = 15V, I_C = 25mA 4 GHz		dBm		20.0 18.5	

*300μs wide pulse measurement ≤2% duty cycle.

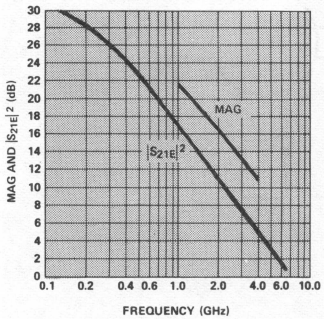


Figure 1. Typical MAG, and $|S_{21E}|^2$ vs. Frequency at V_{CE} = 15 V, I_C = 25 mA.

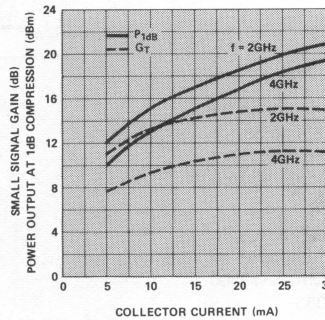


Figure 2. Typical Power Output at 1 dB Compression and Small Signal Gain vs. Current for V_{CE} = 15 V.

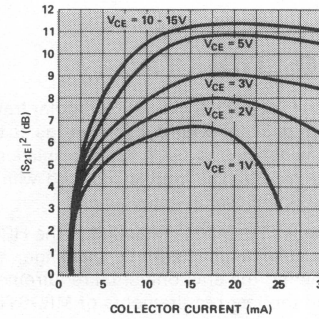


Figure 3. Typical $|S_{21E}|^2$ vs. Current at 2 GHz.

Typical S-Parameters V_{CE} = 15V, I_C = 25mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.63	-58	30.5	33.4	149	-39.2	0.011	62	0.88	-16
200	0.63	-99	28.4	26.2	128	-35.9	0.016	49	0.72	-25
300	0.64	-122	26.1	20.3	115	-34.9	0.018	45	0.61	-28
400	0.64	-136	24.2	16.2	107	-33.6	0.021	42	0.54	-29
500	0.64	-146	22.6	13.4	101	-32.8	0.023	42	0.50	-31
600	0.64	-153	21.2	11.5	96	-32.4	0.024	43	0.48	-32
700	0.64	-158	19.9	9.9	92	-32.0	0.025	43	0.47	-33
800	0.64	-162	18.8	8.8	88	-31.7	0.026	45	0.47	-34
900	0.64	-166	17.8	7.8	85	-31.4	0.027	44	0.48	-34
1000	0.64	-170	16.9	7.0	83	-30.8	0.029	46	0.47	-35
1500	0.66	179	13.5	4.7	70	-29.1	0.035	49	0.44	-40
2000	0.65	172	11.1	3.6	60	-27.1	0.044	53	0.46	-50
2500	0.67	165	9.1	2.9	50	-25.7	0.052	55	0.47	-59
3000	0.64	161	7.6	2.4	40	-24.3	0.061	57	0.52	-66
3500	0.72	156	6.4	2.1	32	-23.3	0.068	53	0.51	-79
4000	0.69	149	5.3	1.8	22	-22.6	0.074	48	0.56	-85
4500	0.70	141	4.4	1.7	14	-21.8	0.081	44	0.55	-92
5000	0.72	136	3.3	1.5	6	-21.3	0.086	39	0.58	-101
5500	0.70	128	2.5	1.3	-3	-20.7	0.092	34	0.62	-109
6000	0.75	122	1.7	1.2	-11	-20.1	0.098	30	0.63	-118
6500	0.70	119	0.8	1.1	-20	-19.6	0.105	26	0.70	-127

HEWLETT PACKARD

LOW COST GENERAL PURPOSE TRANSISTOR

HXTR-3101

Features

HIGH GAIN
19.5 dB Typical at 1 GHz

LOW NOISE FIGURE
1.8 dB Typical NF_{MIN} at 1 GHz

LOW COST HERMETIC PACKAGE

Description

The HXTR-3101 is a low cost NPN bipolar transistor designed for high gain and wide dynamic range up to 4000 MHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes self-alignment and ion implantation techniques. The chip is protected by silicon nitride passivation.

The HXTR-3101 is supplied in the HPAC-100X, a rugged metal/ceramic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the electrical test conditions of MIL-STD-750.

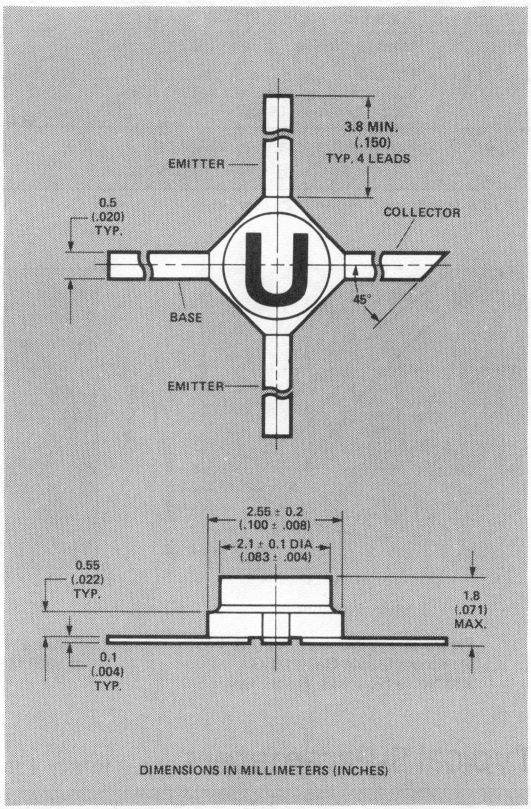
Absolute Maximum Ratings *

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to +150° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 130° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).



Outline HPAC-100X

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$	3001*	V	30		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V	3036	nA			500
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA	3076*		50		180
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 15$ mA		GHz		6	
$\|S_{21E}\|^2$	Transducer Gain at 1000 MHz at $V_{CE} = 10$ V, $I_C = 15$ mA		dB		15.0	
NF_{MIN}	Minimum Noise Figure at 1000 MHz $V_{CE} = 10$ V, $I_C = 10$ mA	3246	dB		1.8	
MAG	Maximum Available Gain at 1000 MHz $V_{CE} = 10$ V, $I_C = 15$ mA		dB		19.5	
C_{cb}	Reverse Transfer Capacitance $I_C = 0$ mA; $V_{CB} = 10$ V; f = 1 MHz		pF		0.33	

*300 μs wide pulse measurement $\leq$ 2% duty cycle.

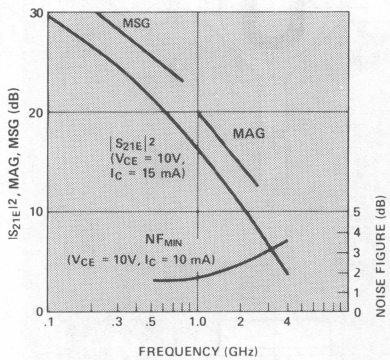


Figure 1. Typical $|S_{21E}|^2$, MAG, Maximum Stable Gain (MSG), and Noise Figure vs. Frequency

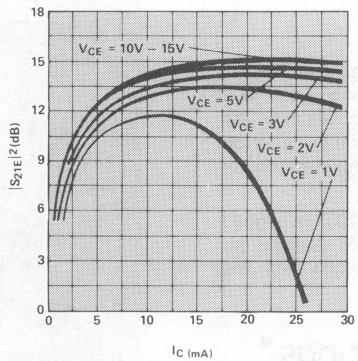


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1000 MHz

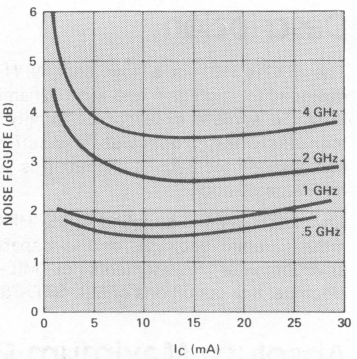


Figure 3. Typical Noise Figure vs. Collector Current (V_{CE} = 10V)

Typical S-Parameters ($V_{CE} = 10$ V, $I_C = 10$ mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.705	-50	27.7	24.266	149	-36.7	0.015	60	0.903	-20
300	0.606	-110	23.5	14.962	116	-30.4	0.030	43	0.624	-36
500	0.565	-139	20.1	10.116	101	-28.9	0.036	41	0.499	-40
800	0.559	-162	16.5	6.683	89	-27.4	0.043	43	0.430	-41
1000	0.571	-169	14.5	5.330	78	-25.7	0.052	44	0.408	-43
1500	0.574	174	11.2	3.627	63	-23.6	0.066	48	0.394	-48
2000	0.591	161	8.9	2.774	49	-21.9	0.080	48	0.392	-57
3000	0.619	143	5.7	1.936	25	-18.8	0.115	45	0.427	-81
4000	0.639	125	3.4	1.488	1	-16.2	0.155	39	0.470	-107

($V_{CE} = 10$ V, $I_C = 15$ mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.641	-60	29.5	29.854	144	-37.6	0.013	57	0.863	-23
300	0.565	-122	24.5	16.788	112	-31.8	0.026	44	0.556	-38
500	0.551	-149	20.7	10.839	98	-30.1	0.031	44	0.444	-40
800	0.553	-168	17.1	7.161	87	-28.1	0.039	50	0.387	-41
1000	0.560	-175	15.1	5.709	77	-26.4	0.048	49	0.363	-42
1500	0.564	171	11.8	3.869	62	-23.6	0.066	54	0.356	-47
2000	0.583	159	9.4	2.955	49	-21.6	0.083	52	0.354	-56
3000	0.611	142	6.3	2.058	26	-18.4	0.120	47	0.389	-81
4000	0.633	124	4.0	1.587	2	-15.9	0.160	39	0.431	-106

HEWLETT PACKARD

LOW COST LINEAR POWER TRANSISTOR

HXTR-3102

Features

HIGH OUTPUT POWER
21 dBm Typical P_{1dB} at 1 GHz

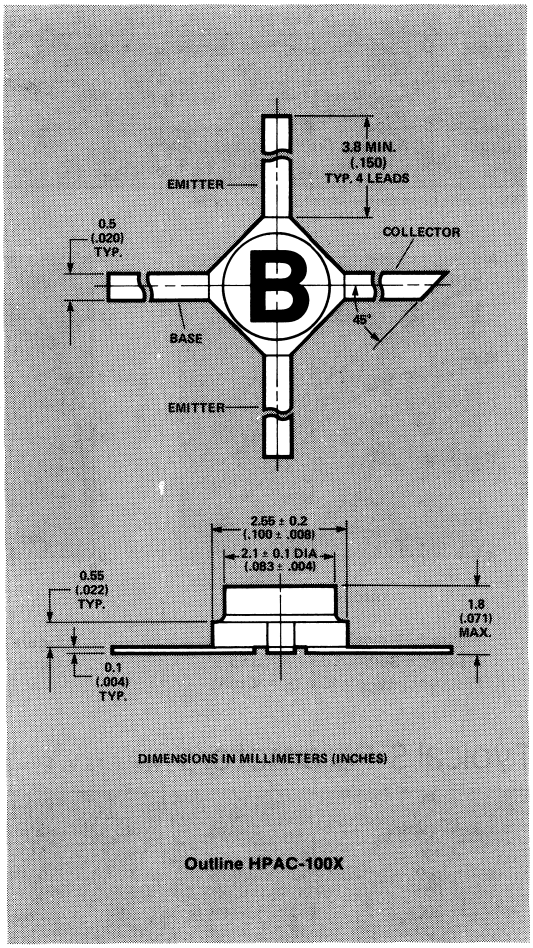
HIGH P_{1dB} GAIN
11.5 dB Typical G_{1dB} at 1 GHz

LOW COST HERMETIC PACKAGE

Description

The HXTR-3102 is a low cost NPN bipolar transistor designed for high linear output power and high gain up to 4000 MHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes self-alignment and ion implantation techniques. The chip is provided with a dielectric scratch protection over its active area and Ta_2N emitter ballast resistors.

The HXTR-3102 is supplied in the HPAC-100X, a rugged metal/ceramic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the electrical test conditions of MIL-STD-750.



Outline HPAC-100X

Absolute Maximum Ratings *

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	35 V
V_{CEO}	Collector to Emitter Voltage	25 V
V_{EBO}	Emitter to Base Voltage	3.5 V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	700 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to +150° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 140° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 μA	3001*	V	35		
I_{CBO}	Collector-Base Cutoff Current at V_{CB} = 20 V	3036	nA			200
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 15 V, I_C = 30 mA	3076*		15		75
f_T	Gain Bandwidth Product at V_{CE} = 15 V, I_C = 30 mA		GHz		6	
$\|S_{21E}\|^2$	Transducer Gain at 1000 MHz at V_{CE} = 15 V, I_C = 30 mA		dB		12.5	
P_{1dB}	Power Output at 1 dB Compression at 1000 MHz V_{CE} = 15 V, I_C = 30 mA		dBm		21.0	
G_{1dB}	Associated 1 dB Compressed Gain at 1000 MHz V_{CE} = 15 V, I_C = 30 mA		dB		15.0	
C_{cb}	Reverse Transfer Capacitance I_C = 0 mA; V_{CB} = 10 V; f = 1 MHz		pF		0.36	

*300 μs wide pulse measurement ≤ 2% duty cycle.

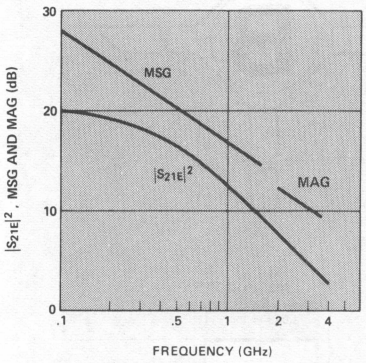


Figure 1. Typical $|S_{21E}|^2$, MAG, and Maximum Stable Gain (MSG) vs. Frequency (V_{CE} = 15 V, I_C = 30 mA)

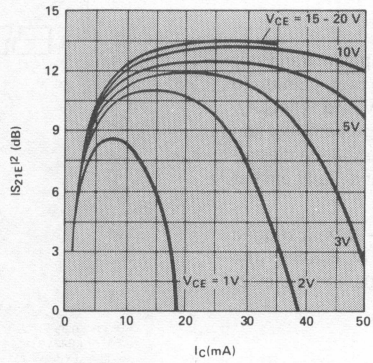


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1000 MHz

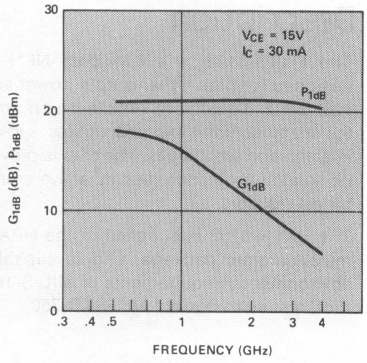


Figure 3. Typical Power Output at 1 dB Gain Compression vs. Frequency

Typical S-Parameters (V_{CE} = 15 V, I_C = 20 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.767	-19	18.9	8.810	165	-36.0	0.016	72	0.985	-10
300	0.699	-52	17.7	7.674	143	-27.0	0.045	60	0.892	-25
500	0.620	-79	16.1	6.383	126	-24.0	0.063	50	0.783	-35
800	0.556	-110	13.8	4.898	109	-22.2	0.078	41	0.654	-40
1000	0.548	-126	12.7	4.317	95	-21.0	0.089	34	0.598	-45
1500	0.523	-155	9.9	3.143	74	-20.2	0.098	30	0.525	-55
2000	0.513	-177	7.9	2.475	57	-19.7	0.103	29	0.489	-63
3000	0.534	156	5.1	1.792	30	-17.8	0.129	31	0.495	-85
4000	0.546	132	3.0	1.412	4	-15.6	0.166	29	0.522	-109

(V_{CE} = 15 V, I_C = 30 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.777	-21	19.7	9.661	164	-35.9	0.016	71	0.985	-10
300	0.694	-57	18.3	8.222	139	-27.1	0.044	58	0.874	-27
500	0.606	-85	16.4	6.607	122	-24.4	0.060	48	0.757	-36
800	0.538	-116	13.9	4.955	105	-22.7	0.073	40	0.630	-40
1000	0.535	-131	12.7	4.296	92	-21.4	0.085	34	0.580	-44
1500	0.513	-159	9.8	3.086	72	-20.4	0.095	32	0.518	-53
2000	0.508	-180	7.7	2.415	55	-19.8	0.102	31	0.488	-62
3000	0.532	153	4.8	1.740	28	-17.8	0.129	33	0.500	-84
4000	0.546	130	2.7	1.362	3	-15.5	0.167	29	0.527	-108

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR

2N6838 (HXTR-3103)

Features

GUARANTEED NOISE FIGURE
2.3 dB Maximum NF_{MIN} at 1 GHz

HIGH GAIN
13.5 dB Minimum $|S_{21E}|^2$ at 1 GHz

HIGH GAIN BANDWIDTH PRODUCT
7.0 GHz Typical f_T

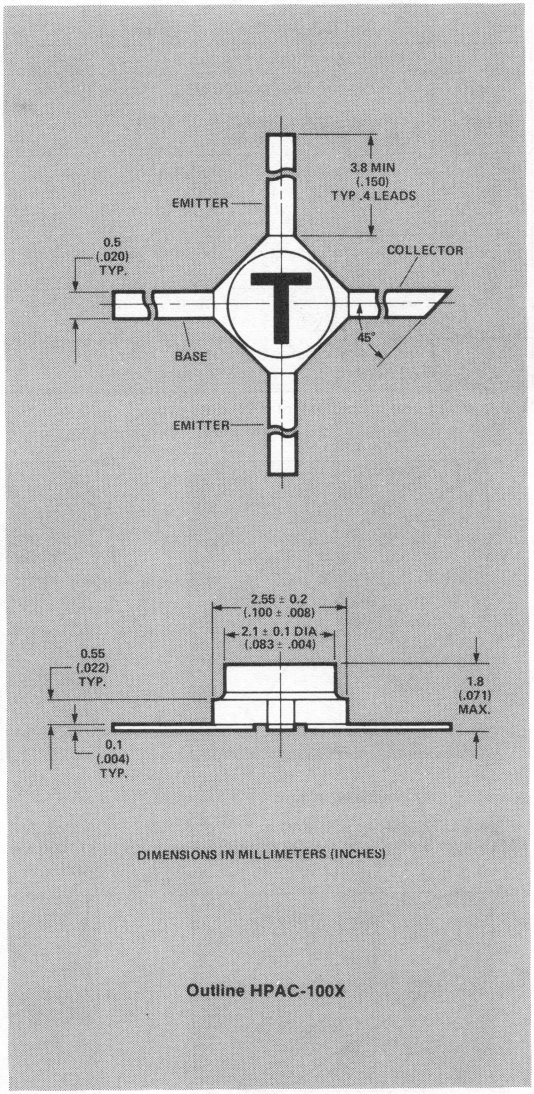
WIDE DYNAMIC RANGE

LOW COST HERMETIC PACKAGE

Description

The HXTR-3103 is an NPN bipolar transistor designed for high gain and wide dynamic range up to 5 GHz. The device utilizes ion implantation and self alignment techniques in its manufacture. The chip is provided with a dielectric scratch protection over its active area.

The HXTR-3103 is supplied in the HPAC-100X, a rugged metal/ceramic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-100X

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	70mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to +150° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 130°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 μA	3001*	V	30		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C = 10 mA	3011*	V	16		
I_{CBO}	Collector-Base Cutoff Current at V_{CB} = 15 V	3036	nA			50
I_{CEO}	Collector-Emitter Leakage Current at V_{CE} = 15V	3041	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 10 V, I_C = 10 mA	3076*		50		180
f_T	Gain Bandwidth Product at V_{CE} = 10 V, I_C = 15 mA		GHz	5.0	7.0	
$\|S_{21E}\|^2$	Transducer Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA		dB	13.5	15.0	
NF_{MIN}	Minimum Noise Figure at 1000 MHz V_{CE} = 10 V, I_C = 10 mA	3246	dB		1.8	2.3
$NF_{(50\Omega)}$	Noise Figure with 50 ohm Source V_{CE} = 10 V, I_C = 10 mA f = 1000 MHz		dB		2.1	
	f = 500 MHz		dB		1.7	
P_{1dB}	Power Output at 1 dB Compression at 1000 MHz V_{CE} = 10 V, I_C = 15 mA		dBm		16.0	
G_{1dB}	Associated 1 dB Compressed Gain at 1000 MHz V_{CE} = 10 V, I_C = 15 mA		dB		16.0	
C_{cb}	Reverse Transfer Capacitance I_C = 0 mA; V_{CB} = 10 V; f = 1 MHz		pF		0.33	

*300μs wide pulse measurement ≤ 2% duty cycle.

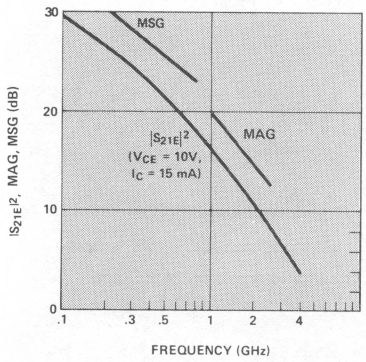


Figure 1. Typical $|S_{21E}|^2$, MAG, Maximum Stable Gain (MSG) vs. Frequency.

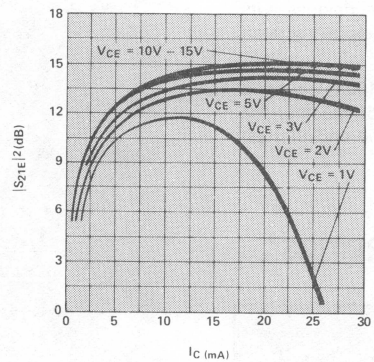


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1000 MHz.

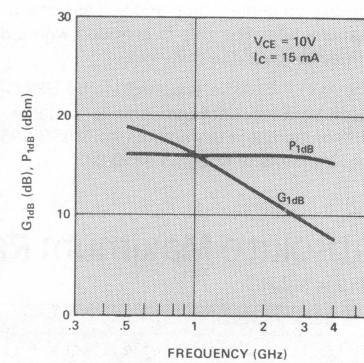


Figure 3. Typical Power Output at 1 dB Gain Compression vs. Frequency.

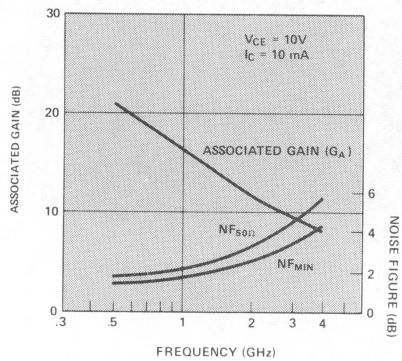


Figure 4. Typical Noise Figure vs. Frequency.

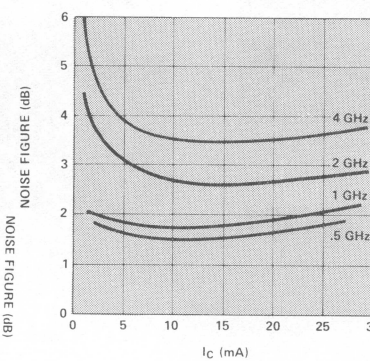


Figure 5. Typical Noise Figure vs. Collector Current.

Typical Noise Parameters

V_{CE} = 10 V, I_C = 10 mA

Freq. (GHz)	NF_{MIN} (dB)	Γ_o Mag.	Γ_o Ang.	R_N (Ohms)
.5	1.4	.121	96	114.4
1.0	1.7	.301	121	15.2
2.0	2.5	.461	173	5.2
3.0	3.3	.553	-157	8.4
4.0	4.2	.648	-139	13.4

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	.70	-50	27.7	24.26	149	-36.7	.015	60	.90	-20
200	.64	-86	25.6	19.05	129	-32.2	.025	49	.74	-31
300	.60	-110	23.5	14.96	116	-30.4	.030	43	.62	-37
400	.57	-127	21.6	12.02	108	-29.6	.033	41	.54	-38
500	.56	-139	20.1	10.11	102	-28.9	.036	41	.49	-40
600	.55	-149	18.7	8.61	97	-28.5	.038	42	.46	-40
700	.56	-157	17.5	7.49	93	-27.9	.040	43	.44	-42
800	.55	-162	16.5	6.68	89	-27.4	.043	44	.43	-42
900	.55	-168	15.5	5.95	85	-26.9	.045	46	.41	-43
1000	.57	-169	14.5	5.33	78	-25.7	.052	42	.40	-40
1500	.57	174	11.2	3.62	63	-23.6	.066	48	.39	-48
2000	.59	162	8.9	2.77	49	-21.9	.080	48	.39	-57
2500	.61	153	7.2	2.28	37	-20.4	.096	48	.39	-71
3000	.61	143	5.7	1.93	25	-18.8	.115	45	.42	-81
3500	.65	134	4.5	1.67	13	-17.5	.134	43	.42	-94
4000	.63	125	3.5	1.48	1	-16.2	.155	39	.47	-107

Typical S-Parameters (V_{CE} =V 10 V, I_C = 15 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	.64	-60	29.5	29.85	144	-37.6	.013	57	.86	-24
200	.58	-98	26.9	22.13	124	-33.4	.021	47	.67	-34
300	.56	-122	24.5	16.78	112	-31.8	.026	44	.55	-38
400	.54	-138	22.4	13.18	104	-30.9	.029	43	.48	-39
500	.54	-149	20.7	10.83	98	-30.1	.031	44	.44	-40
600	.53	-157	19.3	9.22	94	-29.5	.033	47	.41	-40
700	.54	-164	18.1	8.03	90	-28.7	.037	49	.39	-41
800	.54	-168	17.1	7.16	87	-28.1	.039	50	.38	-41
900	.54	-173	16.1	6.38	84	-27.4	.043	52	.37	-42
1000	.56	-175	15.1	5.70	77	-26.4	.048	49	.36	-39
1500	.56	171	11.8	3.86	62	-23.6	.066	54	.35	-47
2000	.58	159	9.4	2.95	49	-21.6	.083	52	.35	-56
2500	.61	151	7.7	2.42	38	-20.0	.100	51	.35	-70
3000	.61	142	6.3	2.05	26	-18.4	.120	47	.38	-81
3500	.64	133	5.0	1.78	14	-17.1	.139	44	.38	-94
4000	.63	124	4.0	1.58	2	-15.9	.160	39	.43	-106

HEWLETT PACKARD

LINEAR POWER TRANSISTOR

2N6839
(HXTR-3104)

Features

HIGH OUTPUT POWER
19.0 dBm Minimum P_{1dB} at 1 GHz

HIGH P_{1dB} GAIN
14.0 dB Minimum G_{1dB} at 1 GHz

HIGH GAIN BANDWIDTH PRODUCT
5.5 GHz TYPICAL f_T

LOW COST HERMETIC PACKAGE

Description

The HXTR-3104 is an NPN bipolar transistor designed for high output power and gain up to 4 GHz. Ion implantation and self alignment techniques are used in its manufacture to produce excellent uniformity and reliability. The chip has a dielectric scratch protection over its active area and a Ta_2N ballast resistor for ruggedness.

The HXTR-3104 is supplied in the HPAC-100X, a rugged metal/ceramic package, and is capable of meeting the environmental requirements of MIL-S-19500 and test requirements of MIL-STD-750/883.

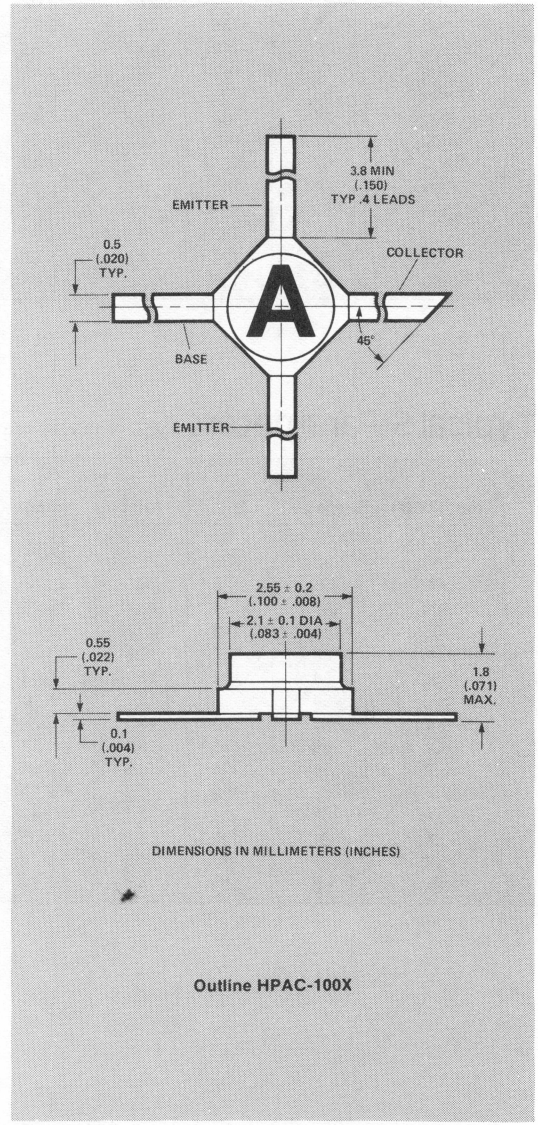
Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	35 V
V_{CEO}	Collector to Emitter Voltage	25 V
V_{EBO}	Emitter to Base Voltage	3.5 V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	700 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to +150° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 140° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).



Outline HPAC-100X

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 μA	3001*	V	35		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C = 15 mA	3011*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B = 30 μA	3026*	V	3.3		
I_{CBO}	Collector-Base Cutoff Current at V_{CB} = 20 V	3036	nA			50
I_{CEO}	Collector-Emitter Leakage Current at V_{CE} = 15 V	3041	nA			75
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 15 V, I_C = 30 mA	3076*		15		75
f_T	Gain Bandwidth Product at V_{CE} = 15 V, I_C = 30 mA		GHz	4.0	5.5	
$\|S_{21E}\|^2$	Transducer Gain at 1000 MHz at V_{CE} = 15 V, I_C = 30 mA		dB	10.5	12.5	
P_{1dB}	Power Output at 1 dB Compression at 1000 MHz at V_{CE} = 15 V, I_C = 30 mA		dBm	19.0	21.0	
G_{1dB}	Associated 1 dB Compressed Gain at 1000 MHz V_{CE} = 15 V, I_C = 30 mA		dB	14.0	16.0	
C_{cb}	Reverse Transfer Capacitance I_C = 0 mA; V_{CB} = 10 V; f = 1 MHz		pF		0.36	

*300μs wide pulse measurement ≤ 2% duty cycle.

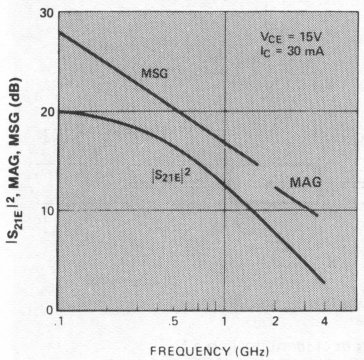


Figure 1. Typical $|S_{21E}|^2$, MAG, and Maximum Stable Gain (MSG) vs. Frequency.

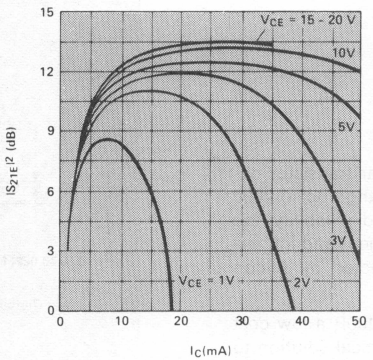


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1000 MHz.

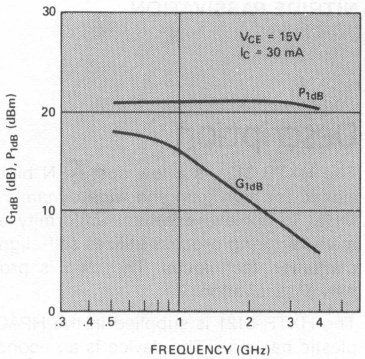


Figure 3. Typical Power Output at 1 dB Gain Compression vs. Frequency.

Typical S-Parameters V_{CE} = 15 V, I_C = 20 mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.76	-19	18.9	8.81	165	-36.0	0.016	72	0.98	-10
300	0.69	-52	17.7	7.67	143	-27.0	0.045	60	0.89	-25
500	0.62	-79	16.1	6.38	126	-24.0	0.063	50	0.78	-35
800	0.55	-110	13.8	4.89	109	-22.2	0.078	41	0.65	-40
1000	0.54	-126	12.7	4.31	95	-21.0	0.089	34	0.59	-45
1500	0.52	-155	9.9	3.14	74	-20.2	0.098	30	0.52	-55
2000	0.51	-177	7.9	2.47	57	-19.7	0.103	29	0.48	-63
3000	0.53	156	5.1	1.79	30	-17.8	0.129	31	0.49	-85
4000	0.54	132	3.0	1.41	4	-15.6	0.166	29	0.52	-109

Typical S-Parameters V_{CE} = 15 V, I_C = 30 mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.77	-21	19.7	9.66	164	-35.9	0.016	71	0.98	-10
300	0.69	-57	18.3	8.22	139	-27.1	0.044	58	0.87	-27
500	0.60	-85	16.4	6.60	122	-24.4	0.060	48	0.75	-36
800	0.53	-116	13.9	4.95	105	-22.7	0.073	40	0.63	-40
1000	0.53	-131	12.7	4.29	92	-21.4	0.085	34	0.58	-44
1500	0.51	-159	9.8	3.08	72	-20.4	0.095	32	0.51	-53
2000	0.50	-180	7.7	2.41	55	-19.8	0.102	31	0.48	-62
3000	0.53	153	4.8	1.74	28	-17.8	0.129	33	0.50	-84
4000	0.54	130	2.7	1.36	3	-15.5	0.167	29	0.52	-108

HEWLETT PACKARD

LOW COST GENERAL PURPOSE TRANSISTOR

HXTR-3121

NEW

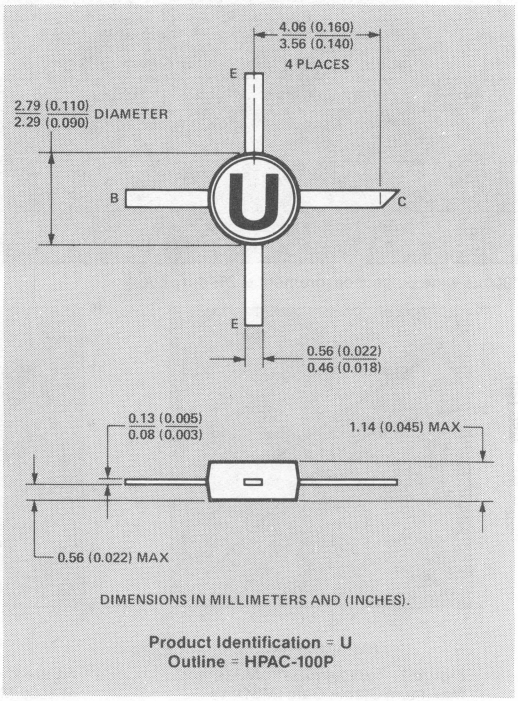
Features

HIGH GAIN
19 dB Typical at 1 GHz

LOW NOISE FIGURE
2.1 dB Typical at 1 GHz

LOW COST PLASTIC PACKAGE

NITRIDE PASSIVATION



Description

The HXTR-3121 is a low cost NPN bipolar transistor designed for high gain and wide dynamic range up to 4000 MHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes self-alignment and ion implantation techniques. The chip is protected by silicon nitride passivation.

The HXTR-3121 is supplied in the HPAC-100P, a low cost plastic package. The device is an economical solution to applications requiring low noise and high gain over VHF, UHF and microwave frequencies.

Absolute Maximum Ratings*

T_{AMB} = 25° C

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	25 V
V_{CEO}	Collector to Emitter Voltage	15 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	250 mW
T_J	Junction Temperature	150° C
T_{STG}	Storage Temperature	-65° to 150° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

NOTES:

1. A Θ_{JA} of 500° C/W should be used for derating and junction temperature calculations: $T_J = (P_D \times \Theta_{JA}) + T_{AMB}$.
2. Maximum soldering temperature is 260° C for 5 seconds.

Typical Noise Parameters

V_{CE} = 10 V I_C = 10 mA

Freq. @ Hz	NF_{MIN} dB	G_A dB	Γ_O Source		Γ_L Load		R_N
			Mag.,	Ang.	Mag.,	Ang.	
0.5	1.7	20.6	0.13,	41	0.59,	23	19
1.0	2.1	14.6	0.12,	72	0.40,	51	25
1.5	2.4	12.4	0.37,	138	0.56,	53	8
2.0	2.8	10.6	0.39,	164	0.43,	72	11
2.5	3.4	8.5	0.34,	180	0.52,	76	14
3.0	3.6	7.7	0.42,	-164	0.55,	85	13
3.5	4.2	7.3	0.53,	-156	0.67,	84	10
4.0	4.7	6.9	0.61,	-143	0.56,	93	19

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 μA	V	25		
I_{CBO}	Collector-Base Cutoff Current at V_{CE} = 15 V	nA			500
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 15 mA, I_C = 15 mA		40	80	180
f_T	Gain Bandwidth Product at V_{CE} = 10 V, I_C = 15 mA	GHz		6	
$\|S_{21E}\|^2$	Transducer Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dB		14.2	
NF_{MIN}	Minimum Noise Figure at 1000 MHz at V_{CE} = 10 V, I_C = 10 mA	dB		2.1	
MAG	Maximum Available Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dB		19	
C_{cb}	Collector Base Capacitance V_{CB} = 10 V, I_E = 0, F = 1.0 MHz	pF		0.36	
P_{1dB}	Power Output at 1 dB Compression at 1000 MHz V_{CE} = 10 V, I_C = 15 mA	dBm		15.0	
G_{1dB}	Associated 1 dB Compressed Gain at 1000 MHz V_{CE} = 10 V, I_C = 15 mA	dB		15.0	
G_A	Associated Gain of Minimum Noise Figure, 1000 MHz	dB		14.6	

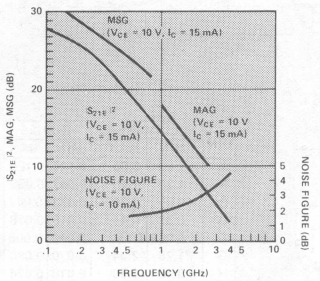


Figure 1. Typical $|S_{21E}|^2$, MAG, MSG, and Noise Figure vs. Frequency

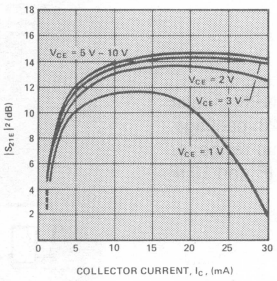


Figure 2. Typical $|S_{21E}|^2$ vs. Collector Current at 1000 MHz.

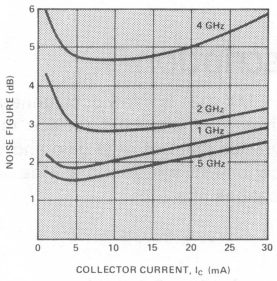


Figure 3. Typical Noise Figure vs. Collector Current (V_{CE} = 10V)

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.687	-45	26.2	20.493	153	-35.2	0.017	69	0.913	-17
300	0.610	-105	22.6	13.466	120	-29.3	0.034	48	0.659	-32
500	0.580	-134	19.3	9.194	103	-27.7	0.041	42	0.530	-36
800	0.565	-157	15.6	6.036	88	-26.4	0.048	42	0.456	-38
1000	0.566	-167	13.8	4.898	81	-25.5	0.053	44	0.434	-40
1500	0.568	178	10.4	3.322	66	-23.7	0.065	48	0.415	-47
2000	0.575	166	8.1	2.526	54	-22.0	0.079	49	0.413	-55
3000	0.595	148	4.8	1.735	33	-19.2	0.110	51	0.430	-74
4000	0.622	131	2.3	1.304	13	-16.8	0.145	49	0.459	-96

(V_{CE} = 10 V, I_C = 15 mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.625	-57	28.2	25.617	148	-35.9	0.016	66	0.876	-20
300	0.575	-118	23.6	15.108	115	-30.6	0.029	47	0.590	-34
500	0.562	-144	19.9	9.923	99	-29.0	0.035	45	0.475	-36
800	0.555	-163	16.1	6.392	86	-27.3	0.043	48	0.415	-37
1000	0.560	-172	14.2	5.153	79	-26.2	0.049	50	0.399	-39
1500	0.563	174	10.8	3.486	65	-23.9	0.064	53	0.386	-46
2000	0.572	163	8.5	2.655	53	-22.0	0.079	54	0.388	-54
3000	0.592	146	5.1	1.808	33	-19.0	0.112	54	0.410	-73
4000	0.618	129	2.6	1.352	13	-16.6	0.148	50	0.443	-94

HEWLETT PACKARD

SURFACE MOUNT GENERAL PURPOSE TRANSISTOR

HSMX-3131

NEW

Features

SURFACE MOUNT

NITRIDE PASSIVATED CHIP

HIGH GAIN
14 dB Typical at 1 GHz

LOW NOISE FIGURE
1.8 dB Typical at 1 GHz

WIDE DYNAMIC RANGE

Description

The HSMX-3131 is a low cost, general purpose NPN bipolar transistor in the plastic surface mount SOT-23 package. This device features high gain and wide dynamic range for an economical solution to a wide variety of VHF and UHF applications.

Absolute Maximum Ratings*

T_{CASE} = 25° C

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	25 V
V_{CEO}	Collector to Emitter Voltage	15 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	250 mW
T_J	Junction Temperature	150° C
T_{STG}	Storage Temperature	-65° to 150° C

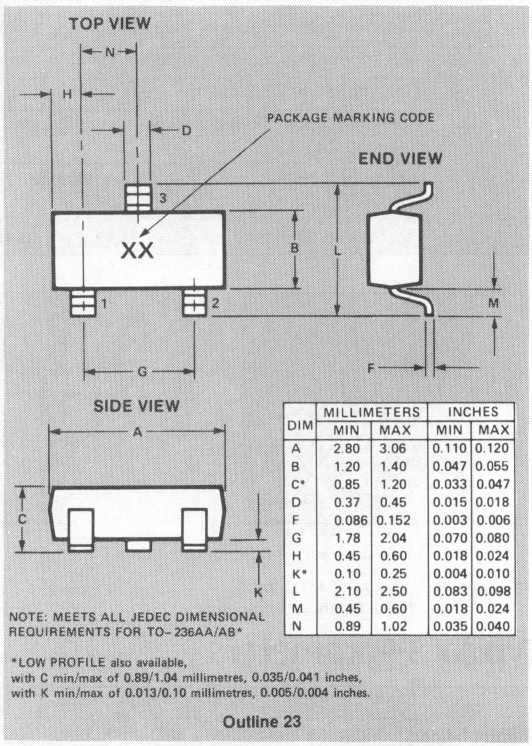
*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
A Θ_{JA} of 500° C/W should be used for derating and junction temperature calculations. ($T_J = P_D \times \Theta_{JA} + T_{case}$)

Typical Noise Parameters

V_{CE} = 10 V, I_C = 10 mA

Freq	NF_{MIN}	G_A	Γ_O Source		Γ_L Load		
@ GHz	dB	dB	Mag.	Angle	Mag.	Angle	R_N
0.5	1.7	18.2	0.36	-10	0.36	-25	60
1.0	1.8	12.5	0.45	-130	0.20	1.09	2
1.5	2.1	9.7	0.32	31	0.30	-87	7
2.0	3.3	5.6	0.50	-171	0.96	67	10



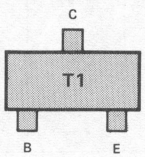
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.06	0.110	0.120
B	1.20	1.40	0.047	0.055
C*	0.85	1.20	0.033	0.047
D	0.37	0.45	0.015	0.018
F	0.086	0.152	0.003	0.006
G	1.78	2.04	0.070	0.080
H	0.45	0.60	0.018	0.024
K*	0.10	0.25	0.004	0.010
L	2.10	2.50	0.083	0.098
M	0.45	0.60	0.018	0.024
N	0.89	1.02	0.035	0.040

NOTE: MEETS ALL JEDEC DIMENSIONAL REQUIREMENTS FOR TO-236AA/AB*

*LOW PROFILE also available,
with C min/max of 0.89/1.04 millimetres, 0.035/0.041 inches,
with K min/max of 0.013/0.10 millimetres, 0.005/0.004 inches.

Outline 23

Package Lead Code Identification



TOP VIEW

MARKING: WHITE – STANDARD PROFILE
ORANGE – LOW PROFILE

Package Characteristics

Lead Material ..... Alloy 42
Lead Finish ..... Tin-Lead, 95-5%
Max. Soldering Temperature ..... 260° C for 5 sec
Min. Lead Strength ..... 2 pounds pull
Typical Package Inductance ..... 2 nH
Typical Package Capacitance .... 0.08 pF (opposite leads)

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 mA	V	25		
I_{CBO}	Collector-Base Cutoff Current at V_{CE} = 15 V	nA			500
h_{FE}*	Forward Current Transfer Ratio at V_{CE} = 15 V, I_C = 15 mA		40	80	180
f_T	Gain Bandwidth Product at V_{CE} = 10 V, I_C = 15 mA	GHz		6	
$\|S_{21E}\|^2$	Transducer Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dB		11.3	
NF_{MIN}	Minimum Noise Figure at 1000 MHz at V_{CE} = 10 V, I_C = 10 mA	dB		1.8	
MAG	Maximum Available Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dB		14	
C_{cb}	Collector-Base Capacitance at V_{CB} = 10 V, I_E = 0, f = 1.0 MHz	pF		0.36	
P_{1dB}	Power Output at 1 dB Compression at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dBm		14	
G_{1dB}	Associated 1dB Compressed Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dB		12	

*300μs wide pulse measurement, 2% duty cycle.

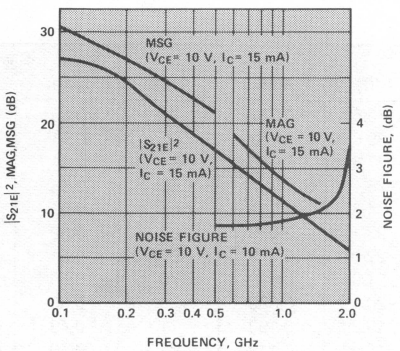


Figure 1. Typical $|S_{21E}|^2$, MAG, MSG, and Noise Figure vs. Frequency.

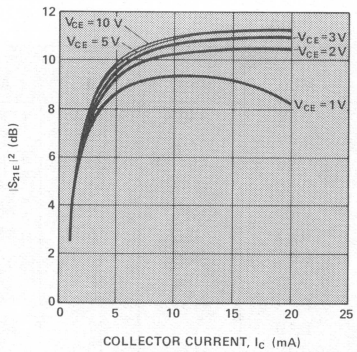


Figure 2. Typical $|S_{21E}|^2$ vs. Collector Current at 1000 MHz.

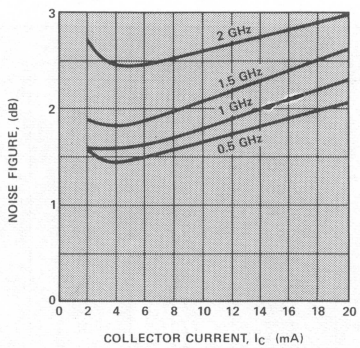


Figure 3. Typical Noise Figure vs. Collector Current, V_{CE} = 10 V.

Typical S-Parameters

V_{CE} = 10 V, I_C = 5 mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.77	-31	21.6	11.95	154	-32.5	0.024	154	0.93	-14
200	0.65	-55	20.0	10.03	135	-28.1	0.039	135	0.82	-21
300	0.53	-75	18.3	8.22	121	-26.0	0.050	121	0.73	-26
400	0.45	-91	16.7	6.80	110	-24.7	0.058	110	0.66	-28
500	0.39	-104	15.2	5.74	102	-23.7	0.065	102	0.62	-29
600	0.34	-116	13.9	4.93	96	-22.8	0.072	96	0.59	-29
700	0.31	-126	12.7	4.33	90	-22.0	0.079	90	0.58	-30
800	0.29	-135	11.7	3.85	85	-21.3	0.086	85	0.56	-31
900	0.27	-144	10.8	3.45	81	-20.6	0.094	81	0.56	-33
1000	0.26	-152	10.0	3.14	77	-19.9	0.102	77	0.55	-34
1100	0.25	-159	9.2	2.89	73	-19.2	0.110	73	0.55	-35
1200	0.25	-166	8.6	2.68	70	-18.5	0.118	70	0.55	-36
1300	0.24	-172	8.0	2.50	67	-17.9	0.127	67	0.54	-38
1400	0.24	-179	7.4	2.45	64	-17.3	0.136	64	0.55	-39
1500	0.23	176	6.9	2.21	61	-16.7	0.146	61	0.55	-41
2000	0.23	148	4.8	1.73	47	-14.0	0.199	47	0.55	-49

V_{CE} = 10 V, I_C = 10 mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.62	-43	25.4	18.69	144	-33.5	0.021	71	0.86	-19
200	0.47	-70	22.9	13.91	124	-29.6	0.033	65	0.71	-25
300	0.36	-91	20.4	10.42	110	-27.3	0.043	64	0.61	-27
400	0.30	-107	18.3	8.22	102	-25.7	0.052	66	0.56	-27
500	0.26	-119	16.6	6.75	95	-24.3	0.061	67	0.53	-27
600	0.23	-130	15.1	5.72	90	-23.1	0.070	68	0.52	-28
700	0.22	-140	13.9	4.97	86	-22.0	0.079	69	0.51	-28
800	0.20	-149	12.8	4.39	81	-21.0	0.089	70	0.50	-29
900	0.19	-157	11.9	3.92	78	-20.1	0.099	70	0.50	-30
1000	0.19	-164	11.0	3.56	74	-19.3	0.109	71	0.49	-32
1100	0.18	-171	10.3	3.27	71	-18.5	0.119	71	0.49	-33
1200	0.18	-178	9.6	3.02	68	-17.8	0.129	71	0.49	-34
1300	0.18	177	9.0	2.81	65	-17.2	0.139	71	0.49	-35
1400	0.18	171	8.4	2.63	62	-16.5	0.149	71	0.50	-37
1500	0.17	165	7.9	2.47	60	-15.9	0.160	70	0.50	-39
2000	0.18	140	5.7	1.93	47	-13.3	0.215	68	0.51	-47

V_{CE} = 10 V, I_C = 15 mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.54	-51	27.0	22.50	138	-34.2	0.020	70	0.71	-21
200	0.38	-80	23.8	15.51	118	-30.4	0.030	67	0.64	-26
300	0.29	-101	21.0	11.18	105	-27.9	0.040	68	0.56	-26
400	0.24	-117	18.8	8.67	98	-26.1	0.050	70	0.52	-26
500	0.21	-129	17.0	7.06	92	-24.5	0.059	71	0.50	-25
600	0.19	-140	15.5	5.94	87	-23.2	0.070	72	0.49	-26
700	0.18	-150	14.2	5.14	83	-22.0	0.080	72	0.48	-26
800	0.17	-158	13.1	4.54	80	-20.9	0.090	73	0.48	-27
900	0.17	-166	12.2	4.05	76	-20.0	0.100	73	0.48	-29
1000	0.16	-173	11.3	3.67	73	-19.1	0.111	73	0.48	-30
1100	0.16	-179	10.5	3.36	70	-18.3	0.121	73	0.48	-31
1200	0.16	175	9.8	3.11	67	-17.6	0.132	72	0.48	-33
1300	0.16	170	9.2	2.89	64	-16.9	0.143	72	0.48	-34
1400	0.16	164	8.6	2.70	62	-16.3	0.153	71	0.48	-36
1500	0.16	159	8.1	2.54	59	-15.7	0.164	71	0.48	-37
2000	0.17	136	6.0	1.99	47	-13.1	0.220	68	0.50	-46

Ordering Information

STANDARD PROFILE

Option T30 = Bulk
Option T31 = Tape and Reel, See Figure 4
Option T32 = Tape and Reel, See Figure 5

LOW PROFILE

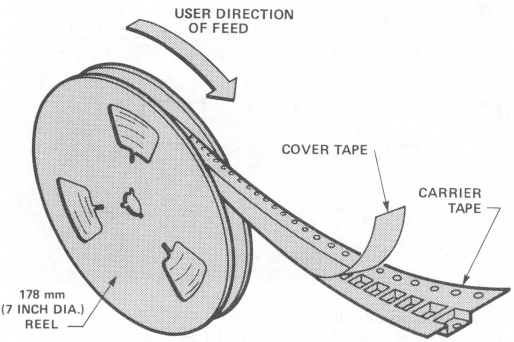
Option L30 = Bulk (100 per bag)
Option L31 = Tape and Reel, See Figure 4
Option L32 = Tape and Reel, See Figure 5

Conforms to Electronic Industries Standard RS-481 "Taping of Surface Mounted Components for Automated Placement". Standard Quantity is 3,000 Devices/Reel.

Specify: Part Number followed by Option Number.
Example:

HSMX-3131 Option X XX

- Bulk or Tape and Reel Option
- Profile: Standard = T, or Low = L
- Part Number
- Surface Mount Transistor
- HP



Please refer to the "Tape and Reel Packaging for Surface Mount Devices" data sheet, publication number 5954-2077*, for more detailed information on tape and reel dimensions.

*Catalog page number 4-127.

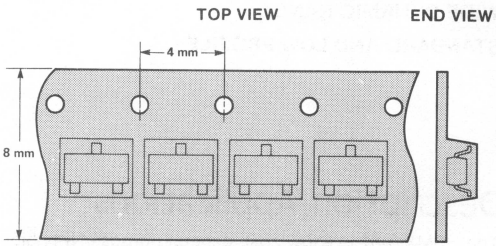


Figure 4. Options T31, L31

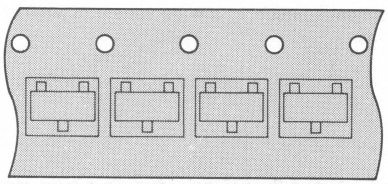


Figure 5. Options T32, L32

HEWLETT PACKARD

SURFACE MOUNT GENERAL PURPOSE TRANSISTOR

HSMX-3151

Features

SURFACE MOUNT PACKAGE

NITRIDE PASSIVATED CHIP

GOLD METALLIZED CHIP

LOW NOISE FIGURE
1.8 dB Typical at 1 GHz

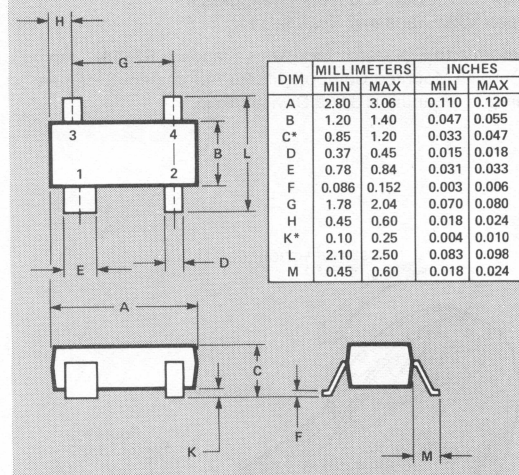
HIGH GAIN
13.5 dB Typical at 1 GHz

WIDE DYNAMIC RANGE

STANDARD AND LOW PROFILE

Available June '87

STANDARD PROFILE



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.06	0.110	0.120
B	1.20	1.40	0.047	0.055
C*	0.85	1.20	0.033	0.047
D	0.37	0.45	0.015	0.018
E	0.78	0.84	0.031	0.033
F	0.086	0.152	0.003	0.006
G	1.78	2.04	0.070	0.080
H	0.45	0.60	0.018	0.024
K*	0.10	0.25	0.004	0.010
L	2.10	2.50	0.083	0.098
M	0.45	0.60	0.018	0.024

Outline 143

*LOW PROFILE also available,
with C min/max of 0.89/1.04 millimeters, 0.035/0.041 inches;
with K min/max of 0.013/0.10 millimeters, 0.0005/0.004 inches.

Description/Applications

The HSMX-3151 is a low cost, general purpose NPN bipolar transistor in the plastic surface mount SOT-143 package. This device features high gain and wide dynamic range for an economical solution to a wide variety of VHF and UHF applications.

Absolute Maximum Ratings*

(T_{CASE} = 25°C)

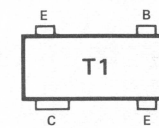
Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	25 V
V_{CEO}	Collector to Emitter Voltage	15 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	250 mW
T_J	Junction Temperature	150°C
T_{STG}	Storage Temperature	-65°C to +150°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
A Θ_{JA} of 500°C/W should be used for derating and junction temperature calculations.
($T_J = P_D \times \Theta_{JA} + T_{CASE}$)

Package Lead Code Identification

TOP VIEW



Marking: White — Standard Profile
Orange — Low Profile

Package Characteristics

Lead Material ..... Alloy 42
Lead Finish ..... Tin-Lead, 95-5%
Max. Soldering Temperature ..... 260°C for 5 sec
Min. Lead Strength ..... 2 pounds pull
Typical Package Inductance ..... 2 nH
Typical Package Capacitance ..... 0.08 pF (opposite leads)

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	Unit	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 μA	V	30		
I_{CBO}	Collector-Base Cutoff Current at V_{CB} = 15 V	nA			500
h_{FE}*	Forward Current Transfer Ratio at V_{CE} = 10 V, I_C = 10 mA		40	80	250
f_T	Gain Bandwidth Product at V_{CE} = 10 V, I_C = 15 mA	GHz		6	
C_{cb}	Collector Base Capacitance at V_{CB} = 10 V, I_E = 0, F = 1 MHz	pF		0.36	
$\|S_{21E}\|^2$	Transducer Gain at V_{CE} = 10 V, I_C = 15 mA 500 MHz 1000 MHz	dB		 19.5 14.0	
MAG	Maximum Available Gain at V_{CE} = 10 V, I_C = 15 mA 100 MHz	dB		 18	
NF_{MIN}	Minimum Noise Figure at V_{CE} = 10 V, I_C = 10 mA 1000 MHz	dB		 1.8	
G_A	Associated Gain at Minimum Noise Figure 1000 MHz				

*300 μs wide pulse measurement ≤2% duty cycle.

Ordering Information

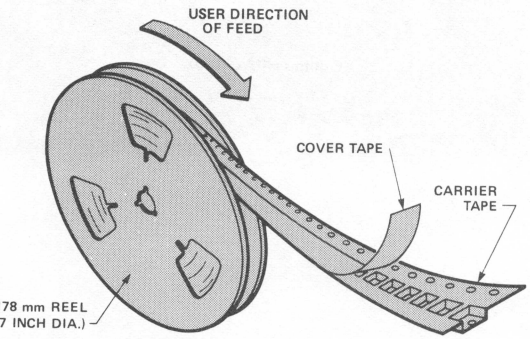
STANDARD PROFILE

Option T30 = Bulk (100 per bag)
Option T31 = Tape and Reel, See Figure 1
Option T32 = Tape and Reel, See Figure 2

LOW PROFILE

Option L30 = Bulk (100 per bag)
Option L31 = Tape and Reel, See Figure 1
Option L32 = Tape and Reel, See Figure 2

Conforms to Electronic Industries Standard RS-481 "Taping of Surface Mounted Components for Automated Placement". Standard Quantity is 3,000 Devices/Reel.



Please refer to the "Tape and Reel Packaging for Surface Mount Devices" data sheet, publication number 5954-2077,* for more detailed information on tape and reel dimensions.

*Catalog page number 4-127.

Specify Part Number followed by Option Number
Example:

HSMX-3151 Option X XX

- XX: Bulk or Tape and Reel Option
- Option X: Profile: Standard = T; or Low = L
- HSMX-3151: Part Number
- HSMX: Surface Mount Transistor
- HP

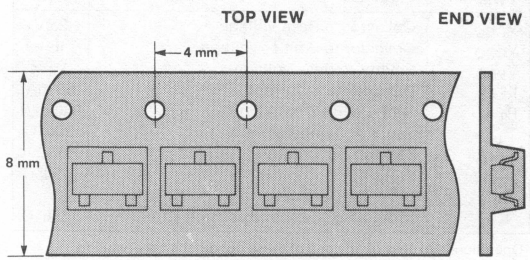


Figure 1. Options T31, L31

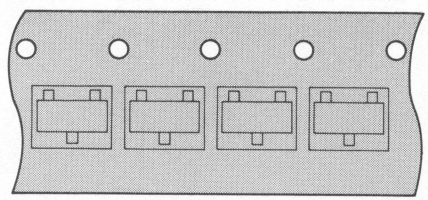


Figure 2. Options T32, L32

HEWLETT PACKARD

LOW COST, LOW NOISE TRANSISTOR

HXTR-3615

Features

LOW NOISE FIGURE
1.4 dB Typical NF_{MIN} at 1 GHz

HIGH ASSOCIATED GAIN
16.6 dB Typical G_A at 1 GHz

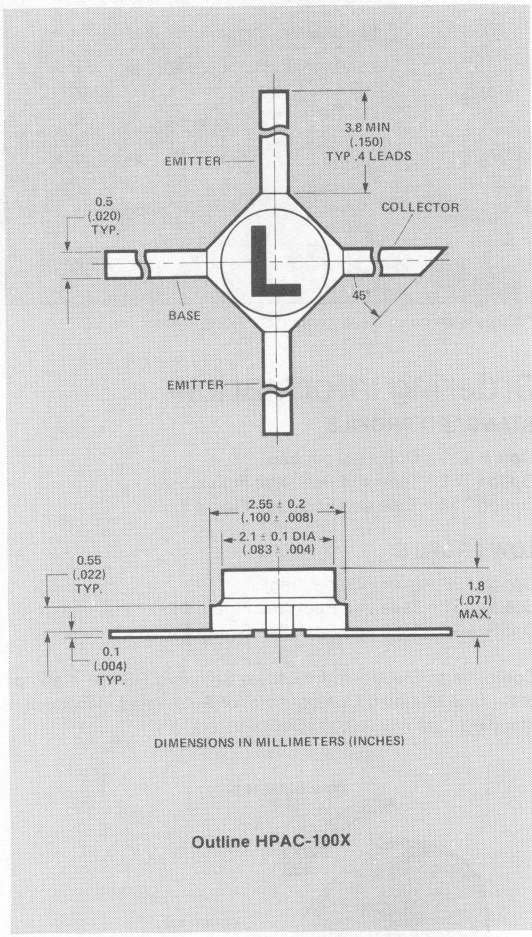
WIDE DYNAMIC RANGE

LOW COST HERMETIC PACKAGE

Description

The HXTR-3615 is a low cost NPN silicon bipolar transistor. Designed to provide low noise, high gain, and wide dynamic range performance for VHF, UHF, and microwave applications. This device is manufactured using ion implantation and self alignment techniques and the transitor chip is protected by silicon nitride passivation.

The HXTR-3615 is supplied in the HPAC-100X, a rugged metal/ceramic package, capable of meeting the environmental requirements of MIL-S-19500 and the electrical test conditions of MIL-STD-750.



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-100X

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	25 V
V_{CEO}	Collector to Emitter Voltage	16 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to +150° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. A Θ_{JC} maximum of 120° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$	3001*	V	25		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA	3011*	V	16		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V	3036				100
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15$ V	3041	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA	3076*		50		180
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 10$ mA		GHz		5	
NF_{MIN}	Minimum Noise Figure at $V_{CE} = 10$ V, $I_C = 10$ mA f = 500 MHz f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246	dB		1.3 1.4 2.1 3.5	
G_A	Associated Gain $V_{CE} = 10$ V, $I_C = 10$ mA f = 500 MHz f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246	dB		21.5 16.6 12.0 7.0	
P_{1dB}	Power Output at 1 dB Gain Compression at 1000 MHz $V_{CE} = 15$ V, $I_C = 18$ mA		dBm		19.0	
G_{1dB}	Associated 1 dB Compressed Gain at 1000 MHz $V_{CE} = 15$ V, $I_C = 18$ mA		dB		19.0	
C_{cb}	Reverse Transfer Capacitance $V_{CB} = 10$ V, $I_C = 0$ mA f = 1 MHz		pF		0.30	

*300 μs wide pulse measurement $\leq$ 2% duty cycle.

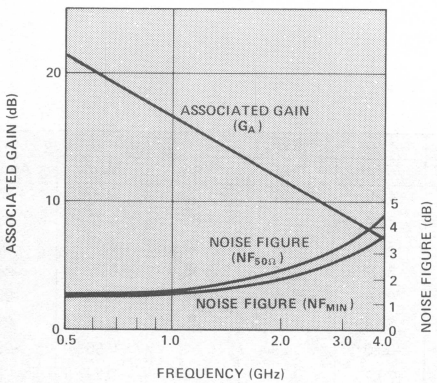


Figure 1. Typical NF_{MIN} and Associated Gain vs. Frequency at $V_{CE} = 10$ V, $I_C = 10$ mA.

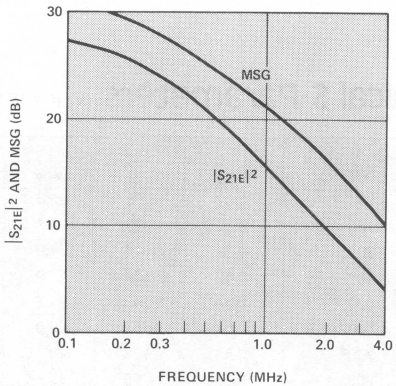


Figure 2. Typical $|S_{21E}|^2$ and Maximum Stable Gain (MSG) vs. Frequency at $V_{CE} = 10$ V and $I_C = 10$ mA.

Typical Noise Parameters

$V_{CE} = 10$ V, $I_C = 10$ mA

Frequency (MHz)	NF_{MIN} (dB)	$NF_{50\Omega}$ (dB)	Γ_o Mag.	Γ_o Ang.	R_N (Ohms)
500	1.3	1.3	(50 Ω)	—	0
1000	1.4	1.6	0.20	135	15.4
2000	2.0	2.4	0.39	-177	4.7
4000	3.5	4.4	0.54	-116	18.1

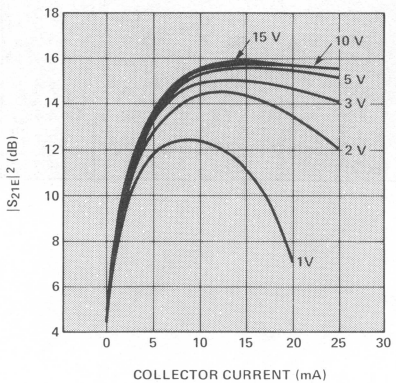


Figure 3. Typical $|S_{21E}|^2$ vs. Current at 1000 MHz.

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.67	-43	27.6	23.92	155	-35.9	0.02	66	0.92	-14
200	0.63	-78	25.9	19.63	136	-33.2	0.02	70	0.81	-23
300	0.59	-103	24.1	15.94	121	-31.4	0.03	53	0.70	-28
400	0.57	-119	22.4	13.22	112	-30.2	0.03	52	0.64	-30
500	0.57	-132	20.9	11.11	105	-28.6	0.04	46	0.59	-32
600	0.55	-141	19.6	9.52	99	-28.4	0.04	49	0.56	-32
700	0.54	-149	18.4	8.30	94	-28.4	0.04	50	0.55	-32
800	0.53	-156	17.4	7.37	89	-28.0	0.04	49	0.53	-32
900	0.53	-162	16.4	6.61	86	-27.3	0.04	51	0.52	-32
1000	0.52	-168	15.6	6.00	83	-26.4	0.05	50	0.50	-34
1500	0.53	172	12.2	4.09	67	-24.7	0.06	55	0.47	-41
2000	0.50	155	9.8	3.11	54	-22.7	0.07	58	0.50	-45
2500	0.54	142	8.1	2.53	43	-20.8	0.09	59	0.47	-55
3000	0.55	130	6.6	2.14	32	-19.0	0.11	58	0.49	-64
3500	0.60	117	5.4	1.87	20	-17.4	0.14	56	0.47	-71
4000	0.61	108	4.3	1.63	10	-16.0	0.16	52	0.49	-83
5000	0.72	90	2.6	1.35	-10	-13.4	0.21	43	0.44	-105
6000	0.81	76	1.2	1.15	-29	-11.2	0.27	32	0.44	-134

Typical S-Parameters (V_{CE} = 15 V, I_C = 18 mA)

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.62	-56	29.3	29.17	148	-40.0	0.01	69	0.90	-16
200	0.59	-93	27.1	22.60	129	-35.4	0.02	66	0.77	-23
300	0.57	-116	24.9	17.66	115	-34.0	0.02	50	0.67	-26
400	0.55	-131	23.0	14.14	107	-31.7	0.03	55	0.62	-26
500	0.54	-143	21.3	11.65	100	-32.0	0.03	47	0.58	-28
600	0.54	-152	20.0	9.96	95	-30.8	0.03	48	0.56	-27
700	0.53	-158	18.7	8.57	91	-30.0	0.03	51	0.55	-28
800	0.53	-165	17.6	7.57	86	-29.1	0.04	52	0.54	-29
900	0.52	-170	16.6	6.78	83	-28.6	0.04	57	0.53	-28
1000	0.52	-175	15.8	6.16	79	-27.7	0.04	57	0.52	-29
1500	0.52	167	12.4	4.16	65	-25.5	0.05	59	0.50	-37
2000	0.51	152	10.0	3.16	53	-23.2	0.07	63	0.52	-42
2500	0.54	139	8.2	2.57	42	-21.3	0.09	64	0.50	-51
3000	0.56	127	6.7	2.17	30	-19.3	0.11	62	0.52	-61
3500	0.61	115	5.5	1.89	19	-17.8	0.13	59	0.50	-68
4000	0.62	106	4.4	1.66	8	-16.3	0.15	55	0.52	-80
5000	0.74	89	2.7	1.36	-12	-13.6	0.21	45	0.47	-102
6000	0.83	75	1.3	1.16	-31	-11.4	0.27	34	0.46	-130

HEWLETT PACKARD

LOW COST GENERAL PURPOSE TRANSISTOR

HXTR-3625

NEW

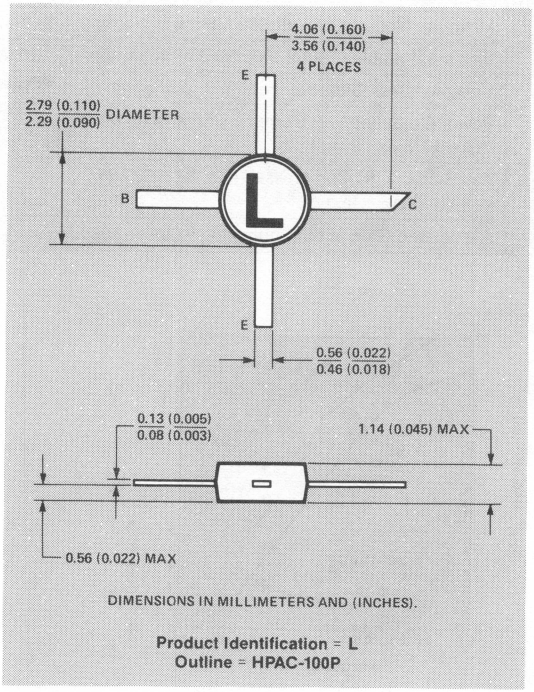
Features

LOW NOISE FIGURE
1.6 dB Typical at 1 GHz

HIGH GAIN
16.8 dB Typical at 1 GHz at Noise Figure Bias

LOW COST PLASTIC PACKAGE

NITRIDE PASSIVATED FOR GREATER RELIABILITY



Product Identification = L
Outline = HPAC-100P

Description

The HXTR-3625 is a low cost NPN bipolar transistor designed for low noise, high gain and wide dynamic range up to 4000 MHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes self-alignment and ion implantation techniques. The chip is protected by silicon nitride passivation.

The HXTR-3625 is supplied in the HPAC-100P, a low cost plastic package. The device is an economical solution to applications requiring low noise and high gain over VHF, UHF and microwave frequencies.

Absolute Maximum Ratings*

T_{AMB} = 25° C

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	25 V
V_{CEO}	Collector to Emitter Voltage	15 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	250 mW
T_J	Junction Temperature	150° C
T_{STG}	Storage Temperature	-65° to 150° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JA} of 500° C/W should be used for derating and junction temperature calculations: $T_J = (P_D \times \Theta_{JA}) + T_{AMB}$.
2. Maximum soldering temperature is 260° C for 5 seconds.

Typical Noise Parameters

V_{CE} = 10 V I_C = 10 mA

Freq. @ GHz	NF_{MIN} dB	G_A dB	Γ_O Source		Γ_L Load		R_N
			Mag.	Ang.	Mag.	Ang.	
0.5	1.4	22.4	0.06	180	0.62	36	19.6
1.0	1.6	16.8	0.22	131	0.56	46	10.5
1.5	1.8	14.1	0.34	156	0.44	77	5.0
2.0	2.0	12.0	0.39	167	0.48	56	7.8
2.5	2.4	10.3	0.43	-173	0.48	66	6.4
3.0	2.7	9.4	0.48	-166	0.55	74	7.0
3.5	3.1	7.9	0.54	-152	0.65	76	10.3
4.0	3.3	8.1	0.58	-140	0.46	34	17.0

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 μA	V	25		
I_{CBO}	Collector-Base Cutoff Current at V_{CE} = 15 V	nA			500
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 15 mA, I_C = 15 mA		40	80	180
f_T	Gain Bandwidth Product at V_{CE} = 10 V, I_C = 15 mA	GHz		5	
$\|S_{21E}\|^2$	Transducer Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dB		14.8	
NF_{MIN}	Minimum Noise Figure at 1000 MHz at V_{CE} = 10 V, I_C = 10 mA	dB		1.6	
MSG	Maximum Stable Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dB		21	
C_{cb}	Collector Base Capacitance V_{CB} = 10 V, I_E = 0, F = 1.0 MHz	pF		0.32	
P_{1dB}	Power Output at 1 dB Compression at 1000 MHz V_{CE} = 10 V, I_C = 15 mA	dBm		17	
G_{1dB}	Associated 1 dB Compressed Gain at 1000 MHz V_{CE} = 10 V, I_C = 15 mA	dB		13	
G_A	Associated Gain at Minimum Noise Figure,1000 MHz	dB		16.8	

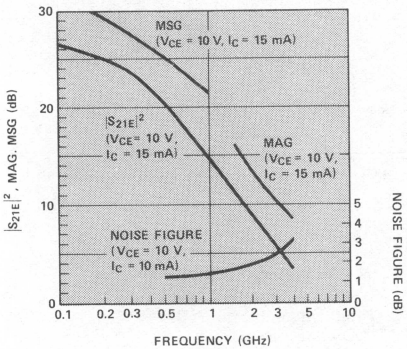


Figure 1. Typical $|S_{21E}|^2$, MAG, MSG, and Noise Figure vs. Frequency

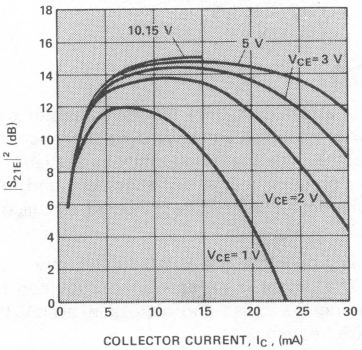


Figure 2. Typical $|S_{21E}|^2$ vs. Collector Current at 1000 MHz

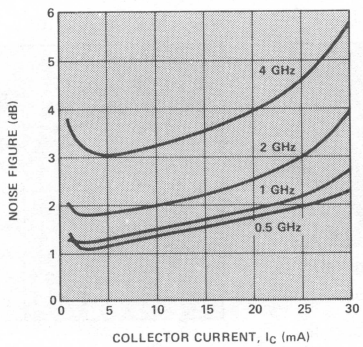


Figure 3. Typical Noise Figure vs. Collector Current (V_{CE} = 10 V)

Typical S-Parameters

(V_{CE} = 10 V, I_C = 10 mA)

Freq.	S_{11}		S_{21}			S_{12}			S_{22}	
(MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.67	-37	25.6	18.95	159	-37.1	0.014	74	0.95	-12
200	0.65	-70	24.3	16.39	141	-31.8	0.026	60	0.84	-22
300	0.64	-96	22.8	13.77	127	-29.8	0.032	50	0.74	-28
400	0.63	-114	21.3	11.55	117	-28.6	0.037	45	0.66	-31
500	0.63	-127	19.9	9.83	110	-28.0	0.040	42	0.61	-33
600	0.63	-137	18.6	8.49	103	-27.6	0.042	40	0.57	-34
700	0.63	-146	17.5	7.46	98	-27.2	0.044	39	0.54	-35
800	0.63	-152	16.4	6.63	94	-27.0	0.045	39	0.52	-36
900	0.63	-158	15.5	5.95	90	-26.8	0.046	39	0.50	-36
1000	0.63	-163	14.7	5.40	86	-26.4	0.048	39	0.49	-37
1100	0.63	-167	13.9	4.94	83	-26.2	0.049	40	0.48	-38
1200	0.63	-171	13.2	4.56	80	-26.0	0.050	41	0.47	-39
1300	0.63	-174	12.5	4.23	77	-25.7	0.052	42	0.47	-40
1400	0.63	-178	11.9	3.95	74	-25.5	0.053	44	0.46	-41
1500	0.63	180	11.4	3.71	72	-25.2	0.055	44	0.46	-42
2000	0.64	167	8.9	2.80	59	-23.8	0.064	49	0.45	-49
2500	0.65	157	7.2	2.28	50	-22.5	0.075	55	0.45	-56
3000	0.66	147	5.6	1.91	40	-21.1	0.088	57	0.46	-64
3500	0.67	138	4.3	1.64	30	-19.6	0.105	58	0.47	-73
4000	0.68	130	3.1	1.43	21	-18.2	0.123	57	0.48	-82

(V_{CE} = 10 V, I_C = 15 mA)

Freq.	S_{11}		S_{21}			S_{12}			S_{22}	
(MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.60	-47	27.3	23.23	155	-37.7	0.013	71	0.92	-14
200	0.61	-86	25.5	18.94	135	-32.8	0.023	56	0.79	-24
300	0.62	-112	23.6	15.19	121	-31.2	0.028	47	0.68	-29
400	0.62	-128	21.8	12.35	112	-30.2	0.031	43	0.61	-31
500	0.62	-140	20.3	10.32	105	-29.6	0.033	43	0.56	-32
600	0.63	-149	18.9	8.81	99	-29.1	0.035	42	0.53	-32
700	0.63	-156	17.7	7.67	94	-28.8	0.036	43	0.51	-33
800	0.63	-161	16.6	6.78	90	-28.4	0.038	44	0.49	-33
900	0.63	-166	15.7	6.08	87	-28.0	0.040	44	0.48	-34
1000	0.63	-170	14.8	5.48	83	-27.8	0.041	45	0.47	-35
1100	0.64	-174	14.0	5.03	80	-27.4	0.043	46	0.47	-36
1200	0.64	-177	13.3	4.62	77	-27.1	0.044	47	0.46	-36
1300	0.64	180	12.6	4.29	74	-26.7	0.046	49	0.46	-38
1400	0.64	177	12.0	3.98	72	-26.4	0.048	51	0.45	-39
1500	0.64	175	11.4	3.73	70	-25.9	0.050	51	0.45	-40
2000	0.65	163	9.0	2.83	58	-24.2	0.062	56	0.45	-47
2500	0.66	154	7.2	2.29	48	-22.5	0.075	61	0.45	-54
3000	0.67	145	5.6	1.92	38	-20.9	0.090	62	0.46	-63
3500	0.68	136	4.3	1.64	29	-19.4	0.107	61	0.47	-72
4000	0.69	128	3.1	1.43	20	-17.9	0.127	60	0.48	-81

HEWLETT PACKARD

SURFACE MOUNT LOW NOISE TRANSISTOR

HSMX-3635

NEW

Features

SURFACE MOUNT

NITRIDE PASSIVATED CHIP

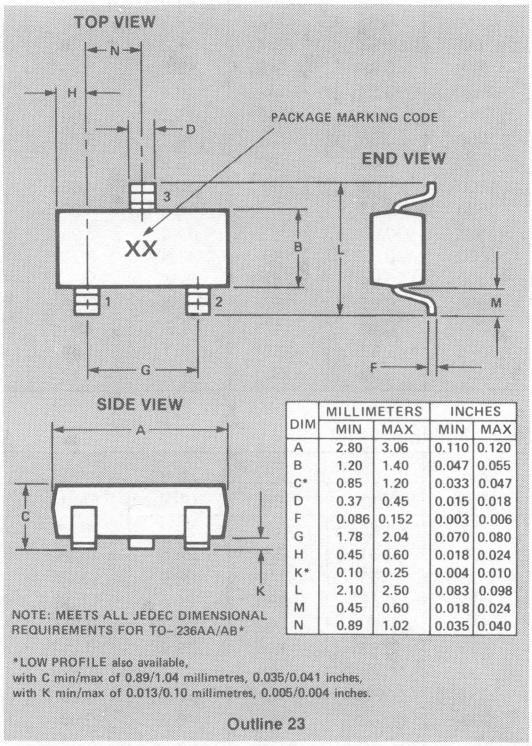
HIGH GAIN
15 dB Typical at 1 GHz

LOW NOISE FIGURE
1.4 dB Typical at 1 GHz

WIDE DYNAMIC RANGE

Description

The HSMX-3635 is a low cost, low noise, high gain NPN transistor in the plastic mount SOT-23 package. This device is designed to provide low noise, high gain, and wide dynamic range performance for a wide variety of VHF and UHF applications.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.06	0.110	0.120
B	1.20	1.40	0.047	0.055
C*	0.85	1.20	0.033	0.047
D	0.37	0.45	0.015	0.018
F	0.086	0.152	0.003	0.006
G	1.78	2.04	0.070	0.080
H	0.45	0.60	0.018	0.024
K*	0.10	0.25	0.004	0.010
L	2.10	2.50	0.083	0.098
M	0.45	0.60	0.018	0.024
N	0.89	1.02	0.035	0.040

NOTE: MEETS ALL JEDEC DIMENSIONAL REQUIREMENTS FOR TO-236AA/AB*

*LOW PROFILE also available, with C min/max of 0.89/1.04 millimetres, 0.035/0.041 inches, with K min/max of 0.013/0.10 millimetres, 0.005/0.004 inches.

Outline 23

Absolute Maximum Ratings*

T_{CASE} = 25° C

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	25 V
V_{CEO}	Collector to Emitter Voltage	15 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	250 mW
T_J	Junction Temperature	150° C
T_{STG}	Storage Temperature	-65° to 150° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

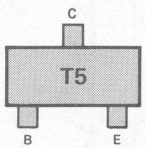
Notes:
A Θ_{JA} of 500° C/W should be used for derating and junction temperature calculations. ($T_J = P_D \times \Theta_{JA} + T_{case}$)

Typical Noise Parameters

V_{CE} = 10 V, I_C = 10 mA

Freq. @ GHz	NF_{MIN} dB	G_A dB	Γ_O Source		Γ_L Load		R_N Ohms
			Mag.	Angle	Mag.	Angle	
0.5	1.3	18.8	0.04	-29	0.36	-25	53
1.0	1.4	13.7	0.18	-65	0.77	89	16
1.5	1.7	10.6	0.81	-14	0.52	-76	3
2.0	2.3	6.8	0.57	-173	0.94	79	4

Package Lead Code Identification



TOP VIEW

MARKING: WHITE – STANDARD PROFILE
ORANGE – LOW PROFILE

Package Characteristics

Lead Material ..... Alloy 42
Lead Finish ..... Tin-Lead, 95-5%
Max. Soldering Temperature ..... 260° C for 5 sec
Min. Lead Strength ..... 2 pounds pull
Typical Package Inductance ..... 2 nH
Typical Package Capacitance .... 0.08 pF (opposite leads)

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 mA	V	25		
I_{CBO}	Collector-Base Cutoff Current at V_{CE} = 15 V	nA			500
h_{FE}*	Forward Current Transfer Ratio at V_{CE} = 15 V, I_C = 15 mA		40	80	180
f_T	Gain Bandwidth Product at V_{CE} = 10 V, I_C = 15 mA	GHz		5	
$\|S_{21E}\|^2$	Transducer Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dB		11.5	
NF_{MIN}	Minimum Noise Figure at 1000 MHz at V_{CE} = 10 V, I_C = 10 mA	dB		1.4	
MAG	Maximum Available Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dB		15	
C_{cb}	Collector-Base Capacitance at V_{CB} = 10 V, I_E = 0, f = 1.0 MHz	pF		0.36	
P_{1dB}	Power Output at 1 dB Compression at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dBm		15	
G_{1dB}	Associated 1dB Compressed Gain at 1000 MHz at V_{CE} = 10 V, I_C = 15 mA	dB		12	

*300 μs wide pulse measurement, 2% duty cycle.

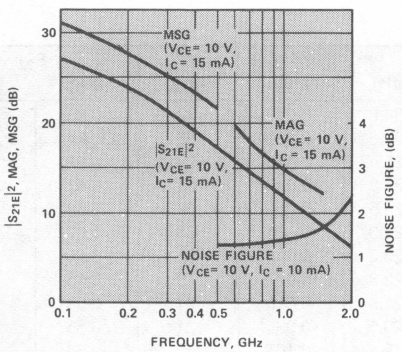


Figure 1. Typical $|S_{21E}|^2$, MAG, MSG and Noise Figure vs. Frequency.

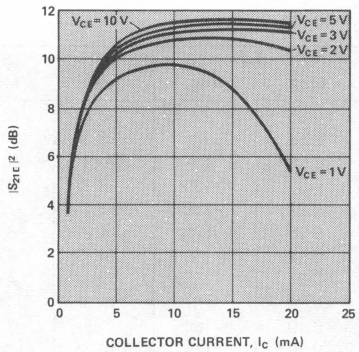


Figure 2. Typical $|S_{21E}|^2$ vs. Collector Current at 1000 MHz.

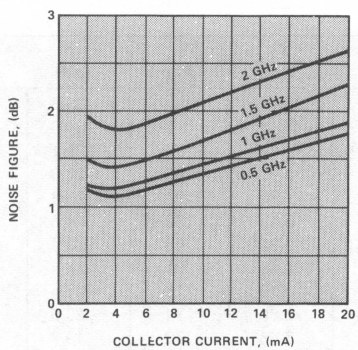


Figure 3. Typical Noise Figure vs. Collector Current, V_{CE} = 10 V.

Typical S-Parameters

V_{CE} = 10 V, I_C = 5 mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.79	-29	21.6	12.06	156	-33.6	0.021	75	0.94	-12
200	0.68	-51	20.3	10.32	138	-29.1	0.035	66	0.85	-19
300	0.57	-71	18.7	8.62	124	-26.8	0.046	61	0.76	-23
400	0.48	-87	17.2	7.22	113	-25.5	0.053	59	0.70	-25
500	0.41	-100	15.8	6.13	105	-24.5	0.059	59	0.66	-26
600	0.37	-111	14.5	5.29	99	-23.7	0.065	59	0.63	-26
700	0.33	-121	13.4	4.66	93	-22.9	0.071	61	0.61	-27
800	0.30	-131	12.4	4.14	88	-22.2	0.077	62	0.60	-28
900	0.28	-140	11.4	3.73	84	-21.5	0.084	63	0.59	-29
1000	0.27	-148	10.6	3.39	80	-20.9	0.091	64	0.59	-30
1100	0.26	-155	9.9	3.13	76	-20.2	0.098	66	0.58	-31
1200	0.25	-162	9.2	2.89	73	-19.6	0.105	67	0.58	-32
1300	0.24	-169	8.6	2.69	70	-19.0	0.112	68	0.58	-33
1400	0.24	-176	8.1	2.53	67	-18.4	0.120	68	0.58	-34
1500	0.23	178	7.5	2.37	64	-17.9	0.128	69	0.58	-35
2000	0.23	149	5.4	1.85	51	-15.2	0.174	70	0.59	-42

V_{CE} = 10 V, I_C = 10 mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.65	-41	25.6	18.97	146	-34.6	0.019	72	0.88	-16
200	0.50	-68	23.2	14.40	126	-30.6	0.030	65	0.74	-22
300	0.39	-89	20.8	10.92	112	-28.4	0.038	64	0.66	-24
400	0.32	-105	18.7	8.65	103	-26.8	0.046	65	0.61	-24
500	0.27	-118	17.1	7.12	97	-25.5	0.053	67	0.58	-24
600	0.25	-129	15.6	6.03	92	-24.3	0.061	68	0.57	-24
700	0.23	-139	14.4	5.24	87	-23.2	0.069	69	0.56	-24
800	0.21	-148	13.3	4.63	83	-22.3	0.077	70	0.55	-25
900	0.20	-157	12.3	4.14	79	-21.4	0.085	71	0.55	-26
1000	0.19	-164	11.5	3.26	76	-20.5	0.094	71	0.55	-27
1100	0.19	-171	10.7	3.44	73	-19.8	0.103	72	0.54	-28
1200	0.19	-178	10.0	3.18	70	-19.1	0.111	72	0.54	-30
1300	0.18	-176	9.4	2.95	67	-18.4	0.120	72	0.54	-31
1400	0.18	-169	8.8	2.76	65	-17.8	0.129	72	0.55	-32
1500	0.18	-164	8.3	2.59	62	-17.2	0.139	72	0.55	-33
2000	0.19	-137	6.1	2.01	50	-14.6	0.187	71	0.56	-40

V_{CE} = 10 V, I_C = 15 mA

Freq. (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} (dB)	S_{21} Mag.	S_{21} Ang.	S_{12} (dB)	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.57	-49	27.0	22.46	140	-35.3	0.017	70	0.84	-18
200	0.41	-79	24.0	15.78	120	-31.5	0.027	66	0.69	-22
300	0.32	-100	21.2	11.50	107	-29.1	0.035	67	0.62	-22
400	0.26	-117	19.0	8.95	99	-27.3	0.043	69	0.58	-22
500	0.23	-129	17.3	7.30	94	-25.8	0.061	70	0.56	-22
600	0.21	-140	15.8	6.15	89	-24.5	0.059	72	0.55	-22
700	0.20	-150	14.5	5.32	85	-23.4	0.068	73	0.54	-22
800	0.19	-159	13.4	4.69	81	-22.3	0.077	74	0.54	-23
900	0.19	-167	12.5	4.19	78	-21.4	0.085	74	0.54	-25
1000	0.18	-174	11.6	3.80	74	-20.5	0.094	74	0.54	-26
1100	0.18	179	10.8	3.48	72	-19.7	0.103	74	0.54	-27
1200	0.18	173	10.1	3.20	69	-19.0	0.113	74	0.54	-28
1300	0.18	167	9.5	2.98	66	-18.3	0.122	74	0.54	-30
1400	0.18	162	8.9	2.79	63	-17.6	0.131	74	0.54	-31
1500	0.18	156	8.4	2.61	61	-17.0	0.141	73	0.54	-32
2000	0.19	132	6.2	2.03	49	-14.4	0.190	71	0.56	-39

Ordering Information

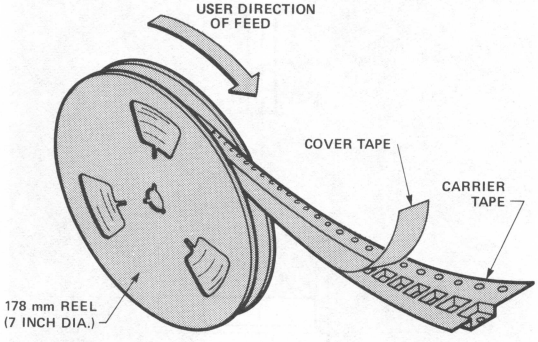
STANDARD PROFILE

Option T30 = Bulk
Option T31 = Tape and Reel, See Figure 4
Option T32 = Tape and Reel, See Figure 5

LOW PROFILE

Option L30 = Bulk (100 per Bag)
Option L31 = Tape and Reel, See Figure 4
Option L32 = Tape and Reel, See Figure 5

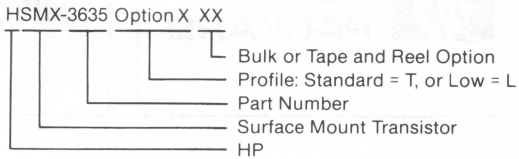
Conforms to Electronic Industries Standard RS-481 "Taping of Surface Mounted Components for Automated Placement". Standard Quantity is 3,000 Devices/Reel.



Please refer to the "Tape and Reel Packaging for Surface Mount Devices" data sheet, publication number 5954-2077*, for more detailed information on tape and reel dimensions.

*Catalog page number 4-127.

Specify: Part Number followed by Option Number.
Example:



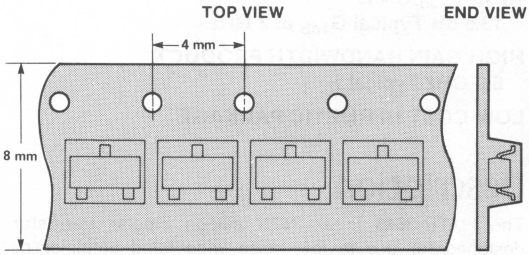


Figure 4. Options T31, L31

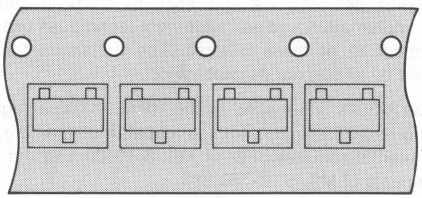


Figure 5. Options T32, L32

HEWLETT PACKARD

LOW COST, HIGH PERFORMANCE TRANSISTOR

HXTR-3645

Features

GUARANTEED NOISE FIGURE
2.3 dB Maximum F_{MIN} at 2 GHz

GUARANTEED ASSOCIATED GAIN
12.2 dB Minimum G_a at 2 GHz

HIGH OUTPUT POWER
19.0 dBm Typical P_{1dB} at 2 GHz

HIGH P_{1dB} GAIN
13.5 dB Typical G_{1dB} at 2 GHz

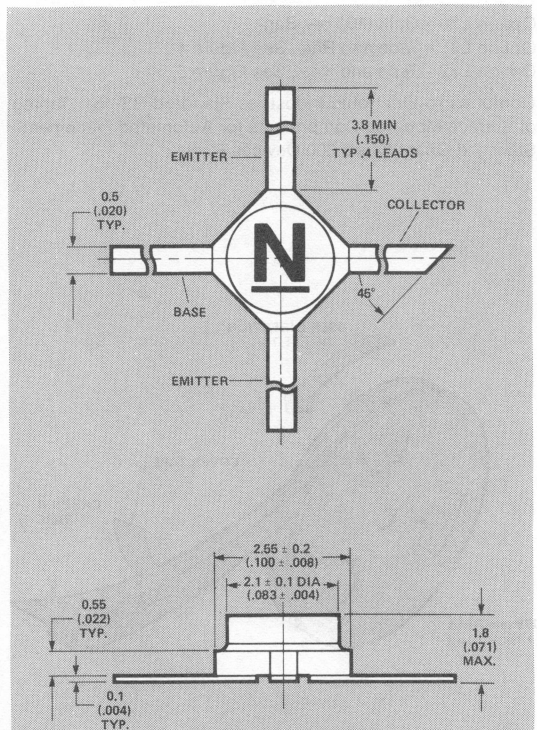
HIGH GAIN BANDWIDTH PRODUCT
6.0 GHz Typical f_T

LOW COST HERMETIC PACKAGE

Description

The HXTR-3645 is an NPN silicon bipolar transistor designed for use in low noise wide band amplifier or medium power oscillation applications requiring superior VHF, UHF, or microwave performance. Excellent device uniformities, performance, and reliability are produced by the ion implantation and self alignment techniques used in the fabrication of these devices. The transistor chip is protected by silicon nitride passivation.

The HXTR-3645 is supplied in the HPAC-100X, a rugged hermetic metal-ceramic package, capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-100X

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to 150° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JA} maximum of 120° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$	3001*	V	30		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA	3011*	V	18		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V	3036	nA			50
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15$ V	3041	nA			50
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA	3076		55		175
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 10$ mA		GHz		6.0	
NF_{MIN}	Minimum Noise Figure $V_{CE} = 10$ V, $I_C = 10$ mA f = 500 MHz f = 1000 MHz f = 1500 MHz f = 2000 MHz	3246	dB		 1.2 1.2 1.4 1.9	 2.3
G_A	Associated Gain $V_{CE} = 10$ V, $I_C = 10$ mA f = 500 MHz f = 1000 MHz f = 1500 MHz f = 2000 MHz	3246	dB	 12.2	 22.5 17.5 14.6 13.0	
P_{1dB}	Power Output at 1 dB Gain at 2000 MHz Compression, $V_{CE} = 15$ V, $I_C = 18$ mA		dBm		19.0	
G_{1dB}	Associated 1 dB Compressed Gain at 2000 MHz $V_{CE} = 15$ V, $I_C = 18$ mA		dB		13.5	
C_{cb}	Reverse Transfer Capacitance $V_{CB} = 10$ V, $I_C = 0$ mA f = 1 MHz		pF		0.27	

*300 μs wide pulse measurement $\leq$ 2% duty cycle.

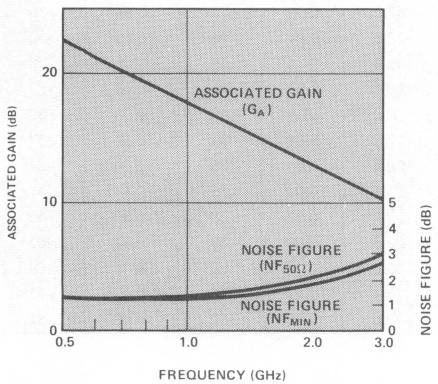


Figure 1. Typical Noise Figure and Associated Gain vs. Frequency at $V_{CE} = 10$ V, $I_C = 10$ mA.

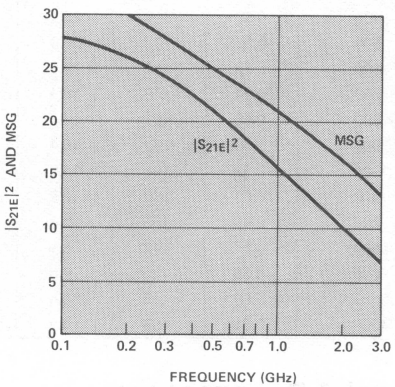


Figure 2. Typical $|S_{21E}|^2$, and Maximum Stable Gain (MSG) vs. Frequency at $V_{CE} = 10$ V and $I_C = 10$ mA.

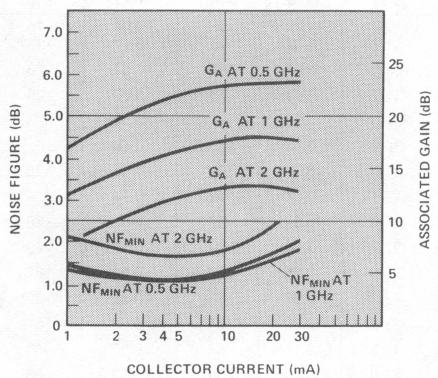


Figure 3. Typical NF_{MIN} and Associated Gain (G_A) vs. Collector Current at $V_{CE} = 10$ V.

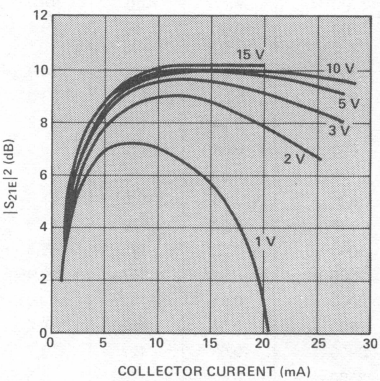


Figure 4. Typical $|S_{21E}|^2$ vs. Current at 2000 MHz.

Typical Noise Parameters

V_{CE} = 10 V, I_C = 10 mA

Frequency (MHz)	NF_{MIN} (dB)	$F_{50\Omega}$ (dB)	Γ_o Mag.	Γ_o Ang.	R_N (Ohms)
500	1.2	1.2	(50 Ω)	—	0
1000	1.2	1.3	0.20	135	7.3
2000	1.9	2.2	0.39	-177	2.2

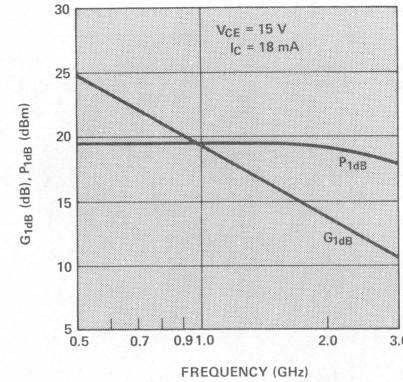


Figure 5. Typical Power Output at 1 dB Compression Gain vs. Frequency.

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.67	-43	27.6	23.92	155	-35.9	0.02	66	0.92	-14
200	0.63	-78	25.9	19.63	136	-33.2	0.02	70	0.81	-23
300	0.59	-103	24.1	15.94	121	-31.4	0.03	53	0.70	-28
400	0.57	-119	22.4	13.22	112	-30.2	0.03	52	0.64	-30
500	0.57	-132	20.9	11.11	105	-28.6	0.04	46	0.59	-32
600	0.55	-141	19.6	9.52	99	-28.4	0.04	49	0.56	-32
700	0.54	-149	18.4	8.30	94	-28.4	0.04	50	0.55	-32
800	0.53	-156	17.4	7.37	89	-28.0	0.04	49	0.53	-32
900	0.53	-162	16.4	6.61	86	-27.3	0.04	51	0.52	-32
1000	0.52	-168	15.6	6.00	83	-26.4	0.05	50	0.50	-34
1500	0.53	172	12.2	4.09	67	-24.7	0.06	55	0.47	-41
2000	0.50	155	9.8	3.11	54	-22.7	0.07	58	0.50	-45
2500	0.54	142	8.1	2.53	43	-20.8	0.09	59	0.47	-55
3000	0.55	130	6.6	2.14	32	-19.0	0.11	58	0.49	-64
3500	0.60	118	5.4	1.87	20	-17.4	0.14	56	0.47	-71
4000	0.61	108	4.3	1.63	10	-16.0	0.16	52	0.49	-83

Typical S-Parameters (V_{CE} = 15 V, I_C = 18 mA)

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.62	-56	29.3	29.17	148	-40.0	0.01	69	0.90	-16
200	0.59	-93	27.1	22.60	129	-35.4	0.02	66	0.77	-23
300	0.57	-116	24.9	17.66	115	-34.0	0.02	50	0.67	-26
400	0.55	-131	23.0	14.14	107	-31.7	0.03	55	0.62	-26
500	0.54	-143	21.3	11.65	100	-32.0	0.03	47	0.58	-28
600	0.54	-152	20.0	9.96	95	-30.8	0.03	48	0.56	-27
700	0.53	-158	18.7	8.57	91	-30.0	0.03	51	0.55	-28
800	0.53	-165	17.6	7.57	86	-29.1	0.04	52	0.54	-29
900	0.52	-170	16.6	6.78	83	-28.6	0.04	57	0.53	-28
1000	0.52	-175	15.8	6.16	79	-27.7	0.04	57	0.52	-29
1500	0.52	167	12.4	4.16	65	-25.5	0.05	59	0.50	-37
2000	0.51	152	10.0	3.16	53	-23.2	0.07	63	0.52	-42
2500	0.54	139	8.2	2.57	42	-21.3	0.09	64	0.50	-51
3000	0.56	127	6.7	2.17	30	-19.3	0.11	62	0.52	-61
3500	0.61	115	5.5	1.89	19	-17.8	0.13	59	0.50	-68
4000	0.62	106	4.4	1.66	8	-16.3	0.15	55	0.52	-80

HEWLETT PACKARD

SURFACE MOUNT LOW NOISE TRANSISTOR

HSMX-3655

Features

Available June '87

SURFACE MOUNT PACKAGE

NITRIDE PASSIVATED CHIP

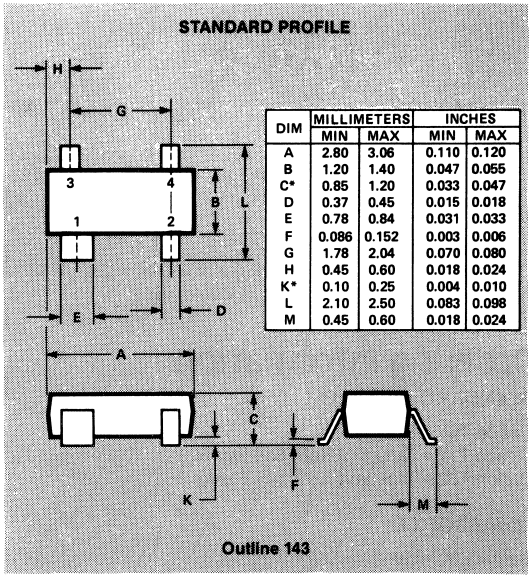
GOLD METALLIZED CHIP

LOW NOISE FIGURE
1.4 dB Typical at 1 GHz

HIGH GAIN
15 dB Typical at 1 GHz

WIDE DYNAMIC RANGE

STANDARD AND LOW PROFILE



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.06	0.110	0.120
B	1.20	1.40	0.047	0.055
C*	0.85	1.20	0.033	0.047
D	0.37	0.45	0.015	0.018
E	0.78	0.84	0.031	0.033
F	0.086	0.152	0.003	0.006
G	1.78	2.04	0.070	0.080
H	0.45	0.60	0.018	0.024
K*	0.10	0.25	0.004	0.010
L	2.10	2.50	0.083	0.098
M	0.45	0.60	0.018	0.024

Outline 143

*LOW PROFILE also available,
with C min/max of 0.89/1.04 millimeters, 0.035/0.041 inches;
with K min/max of 0.013/0.10 millimeters, 0.0005/0.004 inches.

Description/Applications

The HSMX-3655 is a low cost, low noise, high gain NPN transistor in the plastic surface mount SOT-143 package. This device is designed to provide low noise, high gain, and wide dynamic range performance for a wide variety of VHF and UHF applications.

Absolute Maximum Ratings*

(T_{CASE} = 25°C)

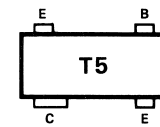
Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	25 V
V_{CEO}	Collector to Emitter Voltage	15 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	250 mW
T_J	Junction Temperature	150°C
T_{STG}	Storage Temperature	-65°C to +150°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
A Θ_{JA} of 500°C/W should be used for derating and junction temperature calculations.
($T_J = P_D \times \Theta_{JA} + T_{CASE}$)

Package Lead Code Identification

TOP VIEW



Marking: White — Standard Profile
Orange — Low Profile

Package Characteristics

Lead Material ..... Alloy 42
Lead Finish ..... Tin-Lead, 95-5%
Max. Soldering Temperature ..... 260°C for 5 sec
Min. Lead Strength ..... 2 pounds pull
Typical Package Inductance ..... 2 nH
Typical Package Capacitance ..... 0.08 pF (opposite leads)

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	Unit	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 μA	V	25		
I_{CBO}	Collector-Base Cutoff Current at V_{CB} = 15 V	nA			500
h_{FE}*	Forward Current Transfer Ratio at V_{CE} = 10 V, I_C = 10 mA		40	80	250
f_T	Gain Bandwidth Product at V_{CE} = 10 V, I_C = 10 mA	GHz		6	
C_{cb}	Collector Base Capacitance at V_{CB} = 10 V, I_E = 0, F = 1 MHz	pF		0.36	
$\|S_{21E}\|^2$	Transducer Gain at V_{CE} = 10 V, I_C = 15 mA 1000 MHz			14.0	
MAG	Maximum Available Gain at V_{CE} = 10 V, I_C = 15 mA 1000 MHz	dB		20	
NF_{MIN}	Minimum Noise Figure at V_{CE} = 10 V, I_C = 10 mA 1000 MHz	dB		1.4	
G_A	Associated Gain at Minimum Noise Figure 1000 MHz			15.0	

*300 μs wide pulse measurement ≤2% duty cycle.

Ordering Information

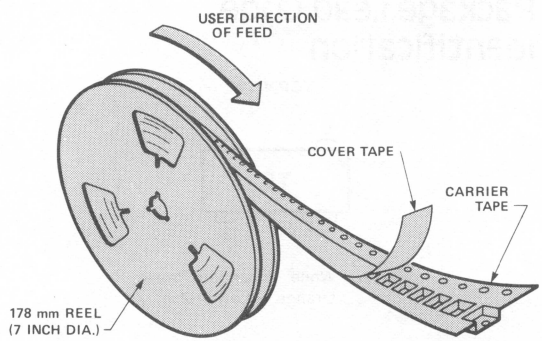
STANDARD PROFILE

Option T30 = Bulk
Option T31 = Tape and Reel, See Figure 1
Option T32 = Tape and Reel, See Figure 2

LOW PROFILE

Option L30 = Bulk
Option L31 = Tape and Reel, See Figure 1
Option L32 = Tape and Reel, See Figure 2

Conforms to Electronic Industries Standard RS-481 "Taping of Surface Mounted Components for Automated Placement". Standard Quantity is 3,000 Devices/Reel.



Please refer to the "Tape and Reel Packaging for Surface Mount Devices" data sheet, publication number 5954-2077,* for more detailed information on tape and reel dimensions.

*Catalog page number 4-127.

Specify Part Number followed by Option Number
Example:

HSMX-3655 Option X XX

- XX: Bulk or Tape and Reel Option
- Option X: Profile: Standard = T; or Low = L
- HSMX-3655: Part Number
- HSMX: Surface Mount Transistor
- HP

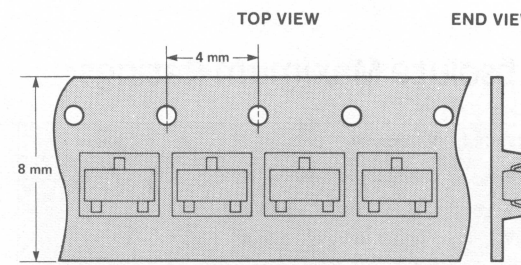


Figure 1. Options T31, L31

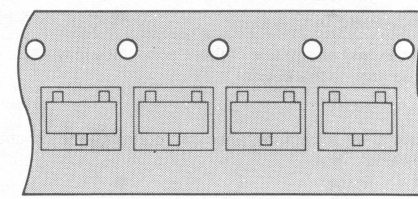


Figure 2. Options T32, L32

HEWLETT PACKARD

LOW COST, HIGH PERFORMANCE TRANSISTOR

HXTR-3675

Features

GUARANTEED NOISE FIGURE
3.4 dB Maximum NF_{MIN} at 4 GHz

GUARANTEED ASSOCIATED GAIN
7.7 dB Minimum G_A at 4 GHz

HIGH OUTPUT POWER
17.5 dBm Typical P_{1dB} at 4 GHz

HIGH P_{1dB} GAIN
8.4 dB Typical G_{1dB} at 4 GHz

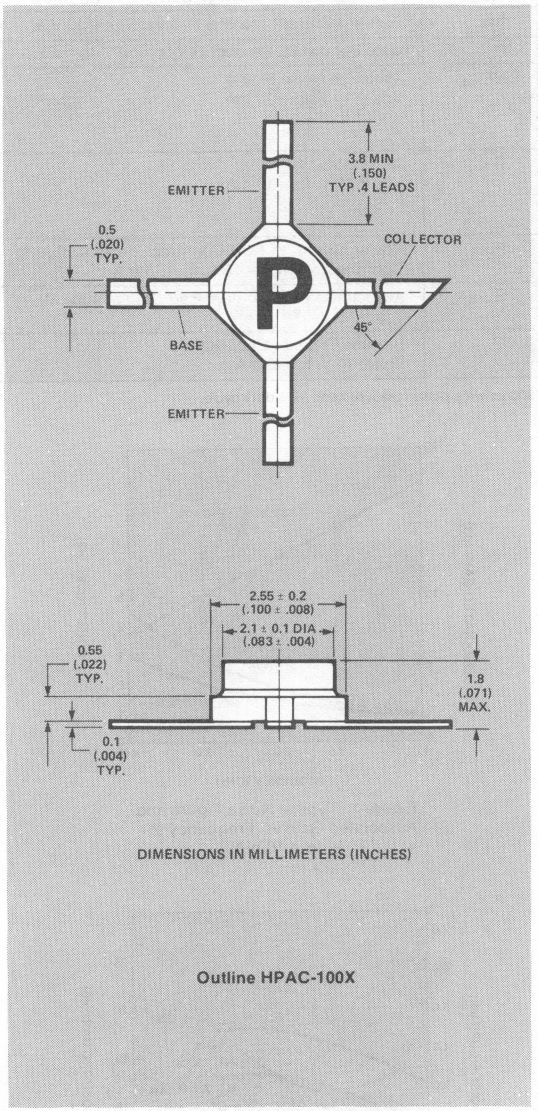
HIGH GAIN BANDWIDTH PRODUCT
6.0 GHz Typical f_T

LOW COST HERMETIC PACKAGE

Description

The HXTR-3675 is an NPN silicon bipolar transistor designed for use in low noise wide band amplifier or medium power oscillation applications requiring superior VHF, UHF, or microwave performance. Excellent device uniformities, performance, and reliability are produced by the ion implantation and self alignment techniques used in the fabrication of these devices. The transistor chip is protected by silicon nitride passivation.

The HXTR-3675 is supplied in the HPAC-100X, a rugged hermetic metal-ceramic package capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-100X

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to +150° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 120° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$	3001*	V	30		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA	3011*	V	18		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V	3036	nA			50
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15$ V	3041	nA			50
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA	3076		55		175
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 10$ mA		GHz		6.0	
NF_{MIN}	Minimum Noise Figure $V_{CE} = 10$ V, $I_C = 10$ mA f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246	dB		1.4 1.9 3.0	3.4
G_A	Associated Gain $V_{CE} = 10$ V, $I_C = 10$ mA f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246	dB	7.7	17.7 13.0 8.3	
P_{1dB}	Power Output at 1 dB Compression at 4000 MHz Compression, $V_{CE} = 15$ V, $I_C = 18$ mA		dBm		17.5	
G_{1dB}	Associated 1 dB Compressed Gain at 4000 MHz $V_{CE} = 15$ V, $I_C = 18$ mA		dB		8.4	
C_{cb}	Reverse Transfer Capacitance f = 1 MHz $V_{CB} = 10$ V, $I_C = 0$ mA		pF		0.29	

*300 μs wide pulse measurement $\leq$ 2% duty cycle.

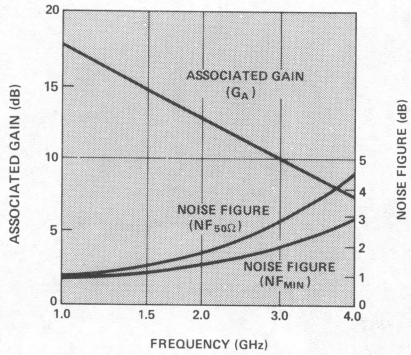


Figure 1. Typical Noise Figure and Associated Gain vs. Frequency at $V_{CE} = 10$ V, $I_C = 10$ mA.

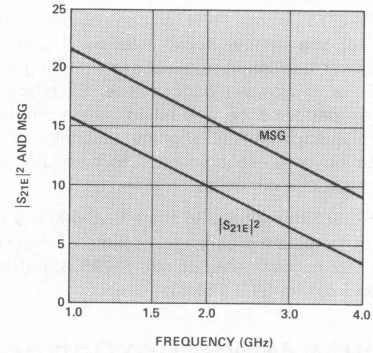


Figure 2. Typical $|S_{21E}|^2$ and Maximum Stable Gain (MSG) vs. Frequency at $V_{CE} = 10$ V and $I_C = 10$ mA.

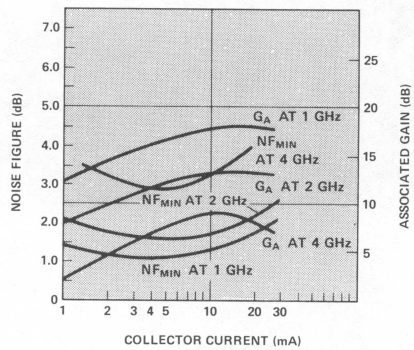


Figure 3. Typical NF_{MIN} and Associated Gain (G_A) vs. collector Current at $V_{CE} = 10$ V.

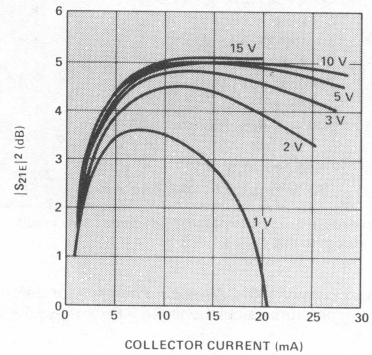


Figure 4. Typical $|S_{21E}|^2$ vs. Current at 4000 MHz.

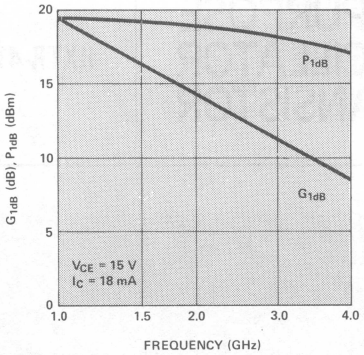


Figure 5. Typical Power Output at 1 dB Compression Gain vs. Frequency.

Typical Noise Parameters

V_{CE} = 10 V, I_C = 10 mA

Frequency (MHz)	NF_{MIN} (dB)	$NF_{50\Omega}$ (dB)	G_A (dB)	Γ_o Mag.	Γ_o Ang.	R_N (Ohms)
1000	1.2	1.3	17.7	0.2	135	6.5
2000	1.8	2.0	13.0	0.4	-177	2.9
4000	2.8	4.1	8.3	0.6	-117	21.5

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

	S_{11}		S_{21}			S_{12}		S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.67	-43	27.6	23.9	155	0.02	66	0.92	-14
200	0.63	-78	25.9	19.6	136	0.02	70	0.81	-23
300	0.59	-103	24.0	15.9	121	0.03	53	0.70	-28
400	0.58	-119	22.4	13.2	112	0.03	52	0.64	-30
500	0.57	-132	20.9	11.1	105	0.04	46	0.59	-32
600	0.55	-141	19.6	9.5	99	0.04	49	0.56	-32
700	0.54	-149	18.4	8.3	94	0.04	50	0.55	-32
800	0.53	-156	17.4	7.4	89	0.04	49	0.53	-32
900	0.53	-162	16.4	6.6	86	0.04	51	0.52	-32
1000	0.52	-168	15.6	6.0	83	0.05	50	0.50	-34
1500	0.53	172	12.3	4.1	67	0.06	55	0.47	-41
2000	0.50	155	9.8	3.1	54	0.07	58	0.50	-46
2500	0.54	142	8.0	2.5	43	0.09	59	0.47	-55
3000	0.55	130	6.4	2.1	32	0.11	58	0.49	-64
3500	0.60	118	5.6	1.9	20	0.14	56	0.47	-71
4000	0.61	108	4.1	1.6	10	0.16	52	0.48	-83
4500	0.68	96	3.5	1.5	-1	0.19	48	0.47	-89
5000	0.72	90	2.9	1.4	-10	0.21	43	0.44	-105
5500	0.76	80	2.3	1.3	-20	0.25	36	0.46	-116
6000	0.81	76	0.8	1.1	-29	0.27	32	0.44	-134
6500	0.78	69	0.2	1.0	-37	0.29	26	0.50	-148

Typical S-Parameters (V_{CE} = 15 V, I_C = 18 mA)

	S_{11}		S_{21}			S_{12}		S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.62	-56	29.3	29.2	148	0.01	69	0.90	-16
200	0.59	-93	27.1	22.6	129	0.02	66	0.77	-23
300	0.57	-116	25.0	17.7	115	0.02	50	0.67	-26
400	0.55	-131	23.0	14.1	107	0.03	55	0.62	-26
500	0.54	-143	21.3	11.6	100	0.03	47	0.58	-28
600	0.54	-152	20.0	10.0	95	0.03	48	0.56	-27
700	0.53	-158	18.7	8.6	91	0.03	51	0.55	-28
800	0.53	-165	17.6	7.6	86	0.04	52	0.54	-29
900	0.52	-170	16.7	6.8	83	0.04	57	0.53	-28
1000	0.52	-175	15.9	6.2	79	0.04	57	0.52	-29
1500	0.52	167	12.5	4.2	65	0.05	59	0.50	-37
2000	0.51	152	10.1	3.2	53	0.07	63	0.52	-42
2500	0.54	139	8.3	2.6	42	0.09	64	0.50	-51
3000	0.56	127	6.9	2.2	30	0.11	62	0.52	-61
3500	0.61	115	5.6	1.9	19	0.13	59	0.50	-68
4000	0.62	106	4.6	1.7	8	0.15	55	0.52	-80
4500	0.69	94	3.5	1.5	-2	0.18	51	0.50	-87
5000	0.74	89	2.9	1.4	-12	0.21	45	0.47	-102
5500	0.77	78	2.3	1.3	-22	0.24	38	0.49	-113
6000	0.83	75	1.6	1.2	-31	0.27	34	0.46	-130
6500	0.78	67	0.1	1.0	-39	0.28	28	0.52	-146

HEWLETT PACKARD

GENERAL PURPOSE OSCILLATOR TRANSISTOR

HXTR-4101

Features

GUARANTEED OUTPUT POWER
19.0 dBm Minimum at 4.3 GHz

HIGH FREQUENCY PERFORMANCE
12 dBm Typical at 8 GHz

USABLE TO 10 GHz

CHARACTERIZED FOR OSCILLATOR APPLICATIONS UP TO 10 GHz

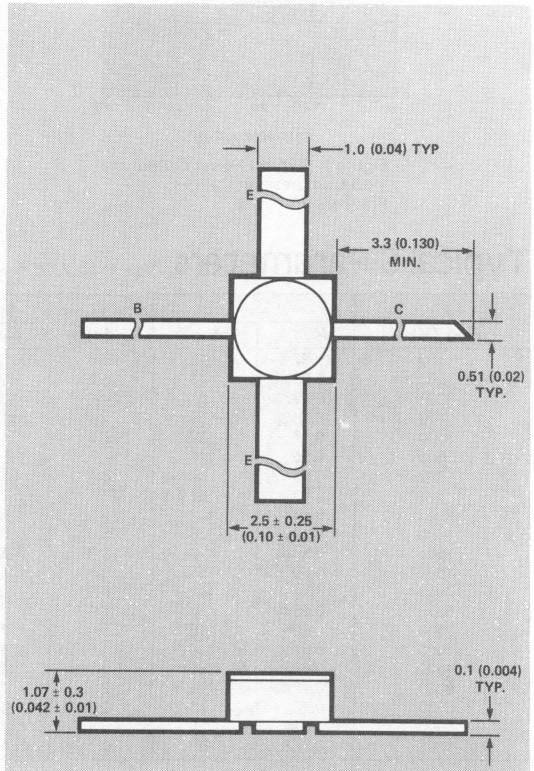
HERMETIC PACKAGE

COMMON BASE CONFIGURATION

Description

The HXTR-4101 is an NPN bipolar transistor designed for consistent high oscillator output. Each device is tested for specified oscillator performance at 4.3 GHz. The device utilizes ion implantation and self alignment techniques in its manufacture. The chip is provided with dielectric scratch protection over its active area.

The HXTR-4101 is supplied in the HPAC-100, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



DIMENSIONS IN MILLIMETERS (INCHES).

Outline HPAC-100

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	−65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 125°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage I_C=100μA	3011*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=15V	3041	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB}=15V	3036	nA			100
h_{FE}	Forward Current Transfer Ratio V_{CE}=15V, I_C=15mA	3076*	—	50	120	220
P_{OSC}	Oscillator Output Power V_{CB} =15V, I_C = 30mA f = 3 GHz 4.3 GHz 6 GHz 8 GHz		dBm	19.0	21.5 20.5 17.0 12.0	
N/C	Phase Noise to Carrier Ratio at 1 KHz from the Carrier (SSB), f = 4.3 GHz		dBc/Hz		-50	

*300μs wide pulse measurement ≤2% duty cycle.

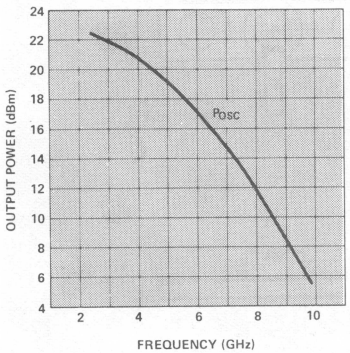


Figure 1. Typical Tuned Power Output vs. Frequency at V_{CB} = 15 V, I_C = 30 mA.

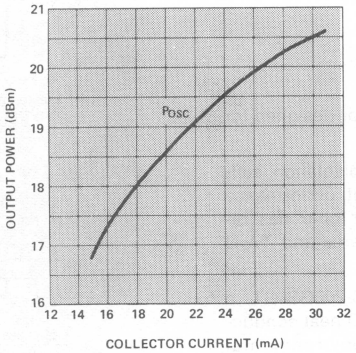


Figure 2. Typical Oscillator Power vs. Current for V_{CB} = 15 V at 4.3 GHz.

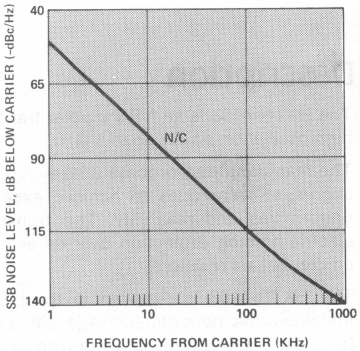


Figure 3. Typical Phase Noise to Carrier Ration (N/C) vs. Frequency from Carrier at 4.3 GHz, V_{CB} = 15 V, I_C = 30 mA.

Typical S-Parameters V_{CB} = 15 V, I_C = 30 mA

Freq. (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
1000	0.93	161	1.93	-29	0.011	127	1.01	-15
1500	0.94	153	1.92	-44	0.023	126	1.04	-31
2000	0.96	144	1.95	-59	0.039	120	1.06	-45
2500	0.98	134	1.97	-76	0.061	113	1.10	-59
3000	0.99	123	1.96	-94	0.086	105	1.12	-74
3500	1.01	115	1.95	-114	0.117	93	1.16	-91
4000	1.02	106	1.87	-133	0.154	84	1.19	-108
4500	1.01	96	1.79	-155	0.186	70	1.20	-127
5000	0.98	88	1.65	-174	0.217	58	1.21	-143
6000	0.91	74	1.32	144	0.245	35	1.10	-176
7000	0.85	61	1.06	109	0.267	17	0.99	157
8000	0.78	49	0.87	74	0.298	1	0.89	135
9000	0.76	44	0.76	60	0.238	-10	0.93	131
10000	0.72	27	0.72	29	0.288	-24	0.89	113
11000	0.70	6	0.68	5	0.302	-38	0.84	102
12000	0.64	-24	0.67	-25	0.320	-58	0.82	92

HEWLETT PACKARD

OSCILLATOR TRANSISTOR HIGH OUTPUT POWER COMMON COLLECTOR

HXTR-4103

Features

HIGH OUTPUT POWER
+30 dBm at 2.0 GHz

HIGH GAIN BANDWIDTH PRODUCT
4.0 GHz Typical f_T

COMMON COLLECTOR CONFIGURATION

HERMETIC FLANGE PACKAGE

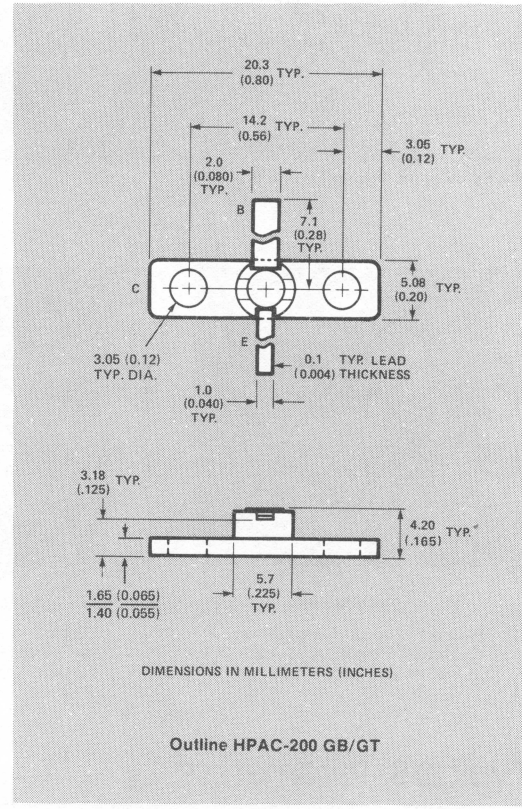
EMITTER BALLAST RESISTORS

Description

The HXTR-4103 is an NPN bipolar transistor designed for high oscillation power up to 5 GHz.

The manufacturing process utilizes ion implantation, self-alignment techniques to achieve excellent performance uniformities and reliability. The transistor chip has dielectric scratch protection over its active area and TA_2N emitter ballast resistors.

The HXTR-4103 is supplied in the HPAC-200GB/GT, a metal/ceramic hermetic package with a BeO heat conductor, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-200 GB/GT

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45 V
V_{CEO}	Collector to Emitter Voltage	27 V
V_{EBO}	Emitter to Base Voltage	4 V
I_C	DC Collector Current	250 mA
P_T	Total Device Dissipation	4 W
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65 to 200° C
—	Lead Temperature Soldering 10 seconds each lead	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 35° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 10 mA	3001*	V	40		
I_{EBO}	Emitter-Base Leakage Current at V_{EB} = 2 V	3036	μA			5
I_{CBO}	Collector-Base Leakage Current at V_{CB} = 20 V	3061	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 18 V, I_C = 110 mA	3076*		15		75
f_T	Gain Bandwidth Product at V_{CE} = 18 V, I_C = 110 mA		GHz		4	
P_{OSC}	Oscillation Power at V_{CE} = 18 V, I_C = 130 mA f = 2 GHz		dBm		30	
η_C	Collector Efficiency at V_{CE} = 18 V, I_C = 130 mA f = 2 GHz		%		43	
C_{cb}	Collector-Base Capacitance at V_{CB} = 18 V		pF		2.7	

*300 μs wide pulse measurement at ≤ 2% duty cycle.

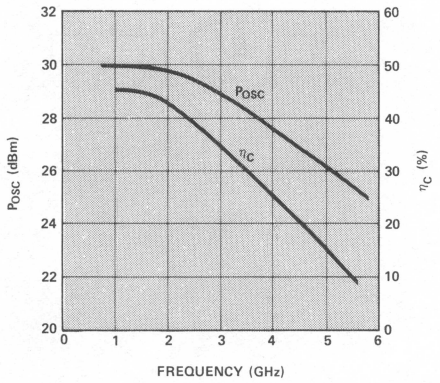


Figure 1. Typical Oscillator Power and Efficiency vs. Frequency V_{CE} = 18 V, I_C = 130 mA

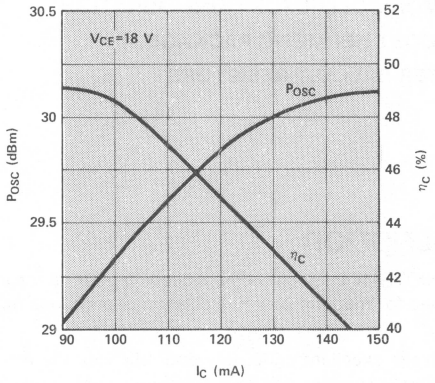


Figure 2. Typical Oscillator Power and Efficiency vs. Collector Current f = 2 GHz

Typical S-Parameters V_{CE} = 18 V, I_C = 130 mA

	S_{11}		S_{21}		S_{12}		S_{22}	
Freq. (MHz)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
1000	0.96	–79	1.67	–56	0.30	24	0.79	130
2000	1.01	–144	1.32	–104	0.47	–24	0.60	95
3000	1.06	164	1.02	–146	0.56	–69	0.50	77
4000	1.10	120	0.84	177	0.60	–111	0.45	68
5000	1.20	74	0.85	142	0.80	–148	0.41	45
6000	1.23	–37	1.08	68	1.32	136	0.11	164
7000	0.84	157	0.15	–8	0.48	58	0.59	76
8000	0.67	99	0.36	78	0.41	68	0.36	64

HEWLETT PACKARD

LOW COST GENERAL PURPOSE OSCILLATOR TRANSISTOR COMMON COLLECTOR

HXTR-4104

Features

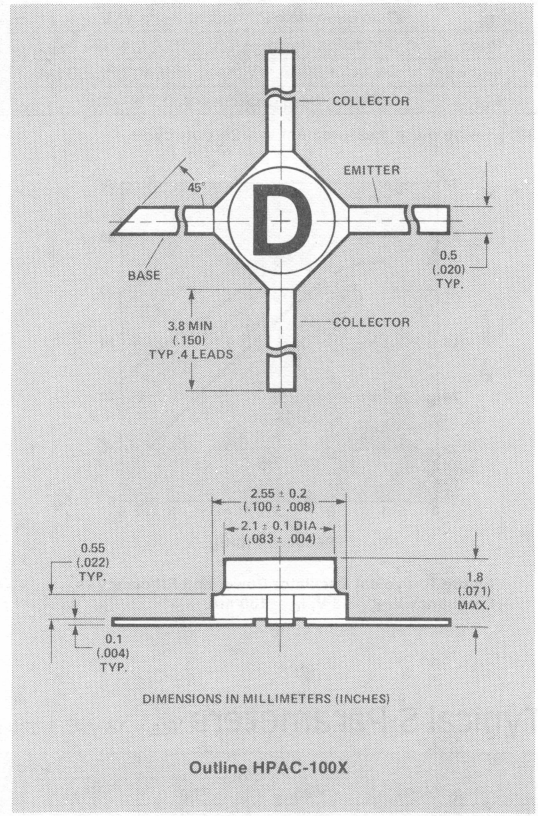
HIGH OUTPUT POWER
+20 dBm Typical at 4.0 GHz

HIGH GAIN BANDWIDTH PRODUCT
5.5 GHz Typical f_T

COMMON COLLECTOR CONFIGURATION

LOW COST HERMETIC PACKAGE

EMITTER BALLAST RESISTORS



Outline HPAC-100X

Description

The HXTR-4104 is an NPN silicon bipolar transistor designed for medium power oscillation applications up to 8 GHz.

To achieve excellent uniformity and reliability the manufacturing process utilizes self-alignment and ion implementation techniques.

The chip is provided with a dielectric scratch protection over its active area and Ta_2N emitter ballast resistors.

The HXTR-4104 is supplied in the HPAC-100X, a rugged hermetic metal/ceramic package capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	40 V
V_{CEO}	Collector to Emitter Voltage	25 V
V_{EBO}	Emitter to Base Voltage	3.5 V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	700 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to +150° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 140° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 3$ mA	3001*	V	40		
I_{EBO}	Emitter-Base Leakage Current at $V_{EB} = 2$ V	3036	μA			2
I_{CBO}	Collector-Base Leakage Current at $V_{CB} = 20$ V	3061	nA			200
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 15$ V, $I_C = 30$ mA	3076*		15		75
f_T	Gain Bandwidth Product at $V_{CE} = 15$ V, $I_C = 30$ mA		GHz		5.5	
P_{OSC}	Oscillation Power at $V_{CE} = 15$ V, $I_C = 35$ mA f = 4 GHz		dBm		20	
η_C	Collector Efficiency at $V_{CE} = 15$ V, $I_C = 35$ mA f = 4 GHz		%		20	
C_{cb}	Collector-Base Capacitance at $V_{CB} = 15$ V		pF		0.43	

*300 μs wide pulse measurement at ≤ 2% duty cycle.

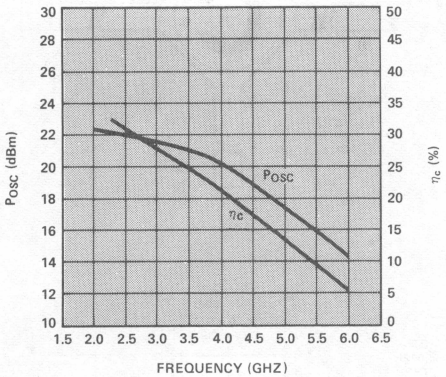


Figure 1. Typical Oscillator Power and Efficiency vs. Frequency $V_{CE} = 15$ V, $I_C = 35$ mA

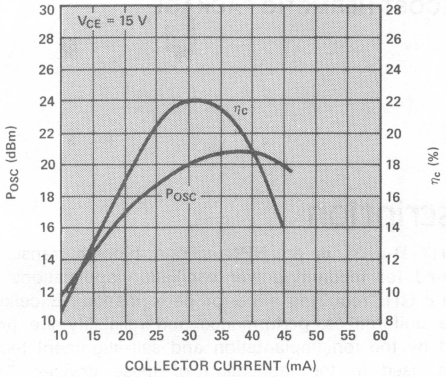


Figure 2. Typical Oscillator Power and Efficiency vs. Collector Current f = 4 GHz

Typical S-Parameters $V_{CE} = 15$ V, $I_C = 35$ mA

	S_{11}		S_{21}		S_{12}		S_{22}	
Freq. (MHz)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
1000	0.90	-33	1.65	-28	0.32	52	0.73	137
2000	0.79	-67	1.48	-53	0.59	24	0.72	98
3000	0.69	-103	1.27	-78	0.79	-4	0.65	62
4000	0.64	-138	1.09	-100	0.89	-32	0.53	29
5000	0.66	-178	0.93	-123	0.90	-61	0.35	2
6000	0.80	147	0.78	-145	0.83	-88	0.07	-11
7000	0.93	121	0.61	-169	0.73	-114	0.17	132
8000	0.99	100	0.44	166	0.60	-140	0.40	114
9000	1.01	81	0.31	145	0.47	-164	0.58	93
10000	1.00	61	0.23	123	0.38	170	0.69	73

HEWLETT PACKARD

LOW COST OSCILLATOR TRANSISTOR COMMON COLLECTOR

HXTR-4105

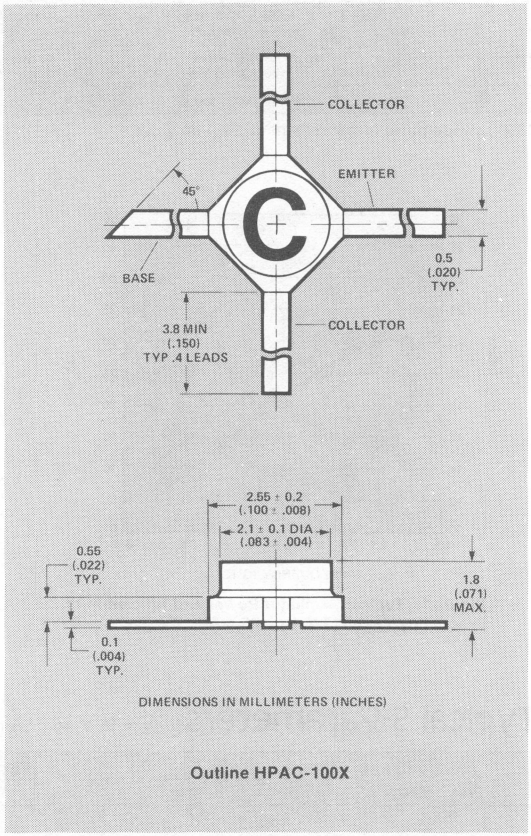
Features

HIGH OUTPUT POWER
+14 dBm at 6.0 GHz

HIGH GAIN BANDWIDTH PRODUCT
6.0 GHz Typical f_T

COMMON COLLECTOR CONFIGURATION

LOW COST HERMETIC PACKAGE



Outline HPAC-100X

Description

The HXTR-4105 is an NPN silicon bipolar transistor designed for medium power oscillation applications to above 8 GHz requiring superior performance. Excellent device uniformities, performance and reliability are produced by the ion implantation and self-alignment techniques used in the fabrication of these devices. The transistor chip has a dielectric scratch protection over its active area.

The HXTR-4105 is supplied in the HPAC-100X, a rugged metal/ceramic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the electrical test conditions of MIL-STD-750.

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65 to 150° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. A Θ_{JC} maximum of 125° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).
2. A MTTF of 1.0 x 10^7 hours will be met or exceeded when the junction temperature is maintained under T_J = 140° C (based on an activation energy of 1.1 eV). For operation above this condition, refer to page 000. "Reliability Performance of Bipolar Transistors".

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 0.1$ mA	3001*	V	30		
I_{EBO}	Emitter-Base Leakage Current at $V_{EB} = 1$ V	3036	μA			10
I_{CBO}	Collector-Base Leakage Current at $V_{CB} = 15$ V	3061	nA			100
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA	3076*		55		175
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 10$ mA		GHz		6	
P_{OSC}	Oscillation Power at $V_{CE} = 15$ V, $I_C = 25$ mA f = 6 GHz		dBm		14	
η_C	Collector Efficiency at $V_{CE} = 15$ V, $I_C = 25$ mA f = 6 GHz		%		7	
C_{CB}	Collector-Base Capacitance at $V_{CB} = 15$ V		pF		0.36	

*300 μs wide pulse measurement at ≤ 2% duty cycle.
**Measurement under low ambient light conditions.

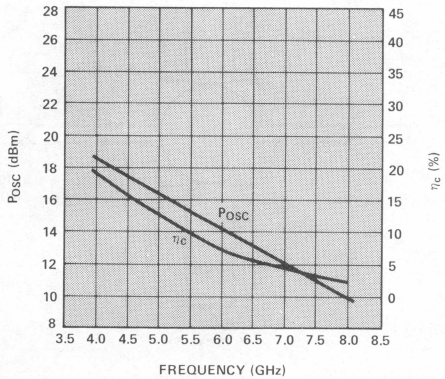


Figure 1. Typical Oscillator Power and Efficiency vs. Frequency $V_{CE} = 15$ V, $I_C = 25$ mA

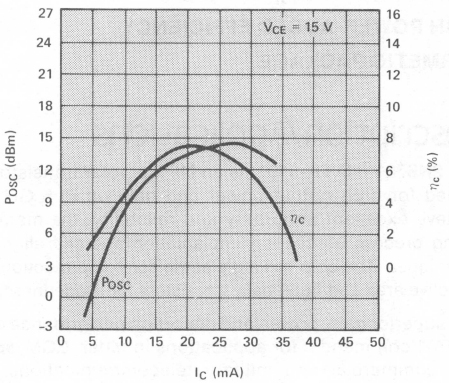


Figure 2. Typical Oscillator Power and Efficiency vs. Collector Current f = 6 GHz

Typical S-Parameters $V_{CE} = 15$ V, $I_C = 25$ mA

Freq. (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
1000	0.91	-32	1.79	-26	0.33	55	0.89	140
2000	0.77	-63	1.60	-50	0.61	28	0.87	104
3000	0.63	-95	1.38	-71	0.80	2	0.80	73
4000	0.53	-126	1.20	-92	0.92	-23	0.72	45
5000	0.51	-165	1.04	-111	0.95	-48	0.60	22
6000	0.63	159	0.92	-129	0.94	-72	0.40	4
7000	0.78	132	0.81	-149	0.89	-95	0.19	-16
8000	0.88	110	0.65	-171	0.79	-120	0.08	133
9000	0.90	89	0.49	166	0.69	-141	0.33	106
10000	0.92	69	0.36	146	0.61	-166	0.51	82

HEWLETT PACKARD

LINEAR POWER TRANSISTOR

2N6701
(HXTR-5101)

Features

HIGH OUTPUT POWER
- **23 dBm Typical P_{1dB} at 2 GHz**
- **22 dBm Typical P_{1dB} at 4 GHz**

HIGH P_{1dB} GAIN
- **13 dB Typical G_{1dB} at 2 GHz**
- **7.5 dB Typical G_{1dB} at 4 GHz**

HIGH POWER-ADDED EFFICIENCY

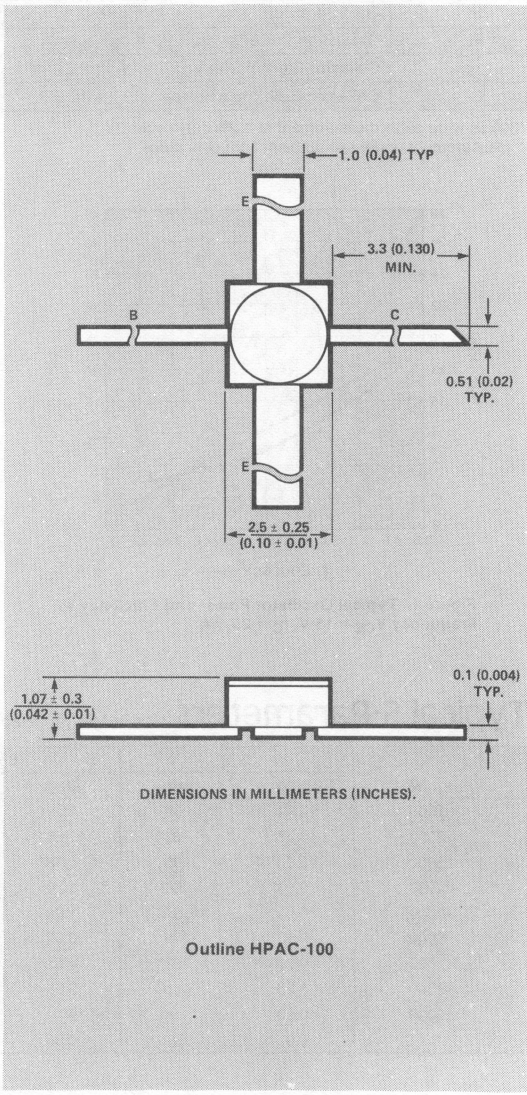
HERMETIC PACKAGE

Description/Applications

The 2N6701 (HXTR-5101) is an NPN bipolar transistor designed for high output power and gain up to 5 GHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes ion implantation and self alignment techniques. The chip has a dielectric scratch protection over its active area and Ta_2N ballast resistors for ruggedness.

The superior gain, power, and distortion performance of the 2N6701 commend it for applications in radar, ECM, space, and commercial and military telecommunications. The 2N6701 features both guaranteed power output and associated gain at 1 dB gain compression.

The 2N6701 is supplied in the HPAC-100, a metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



DIMENSIONS IN MILLIMETERS (INCHES).

Outline HPAC-100

Absolute Maximum Ratings*

(T_{CASE} = 25°C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	1.1 W
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	−65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. A Θ_{JC} maximum of 125°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions		Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 3 mA		3001*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C = 15 mA		3011*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B = 30 μA		3026*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB} = 2 V		3061	μA			2
I_{CES}	Collector-Emitter Leakage Current at V_{CE} = 32 V		3041	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB} = 20 V		3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 18 V, I_C = 30 mA		3076*		15	35	75
P_{1dB}	Power Output at 1 dB Gain Compression	f = 2 GHz f = 4 GHz		dBm	21.0	23.0 22.0	
G_{1dB}	Associated 1 dB Compressed Gain	f = 2 GHz f = 4 GHz		dB	6.5	13 7.5	
P_{SAT}	Saturated Power Output (8 dB Gain) (3 dB Gain)	f = 2 GHz f = 4 GHz		dBm		25.5 25.0	
η	Power-Added Efficiency at 1 dB Compression	f = 2 GHz f = 4 GHz		%		35 24	
IP_3	Third Order Intercept Point, V_{CE} = 18 V, I_C = 30 mA,	f = 4 GHz		dBm		31	
C_{cb}	Reverse Transfer Capacitance I_C = 0 mA; V_{CB} = 10 V;	f = 1 MHz		pF		0.27	

*300 μs wide pulse measurement at ≤2% duty cycle.

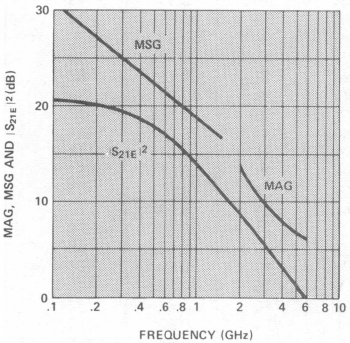


Figure 1. Typical MAG, Maximum Stable Gain (MSG), and $|S_{21E}|^2$, vs. Frequency at V_{CE} = 18 V, I_C = 30 mA.

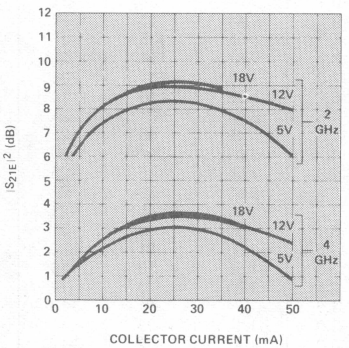


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 2 and 4 GHz.

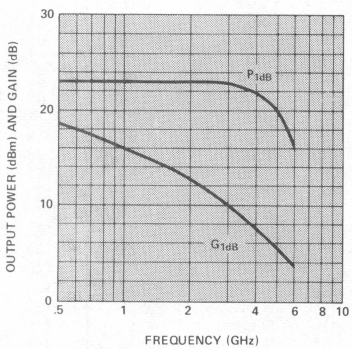


Figure 3. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Frequency at V_{CE} = 18 V, I_C = 30 mA.

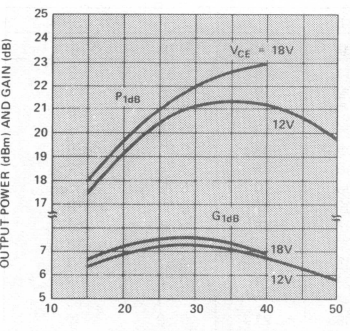


Figure 4. Typical P_{1dB} Linear Power and Associated 1 dB Compressed Gain vs. Current at V_{CE} = 12 and 18 V at 4 GHz.

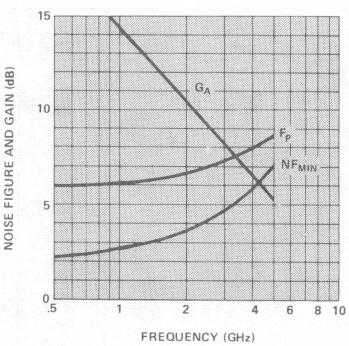


Figure 5. Typical Noise Figure NF_{MIN} and Associated Gain (G_A) when tuned for Minimum Noise vs. Frequency at V_{CE} = 18 V, I_C = 10 mA. Typical Noise Figure (F_P) when tuned for Max P_{1dB} at V_{CE} = 18 V, I_C = 30 mA.

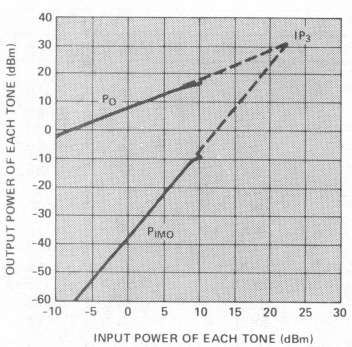


Figure 6. Typical Two Tone 3rd Order Intermodulation Distortion at 2 GHz for a frequency separation of 5 MHz at V_{CE} = 18 V, I_C = 30 mA.

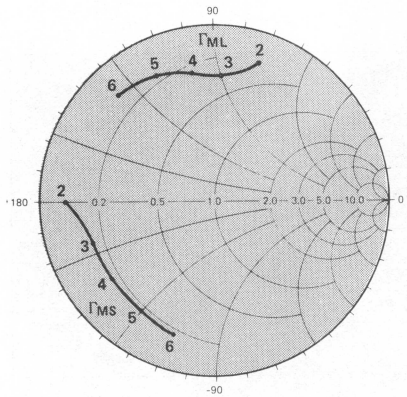


Figure 7. Typical Γ_{MS}, Γ_{ML}, (calculated from the average S-parameters) in the 2 to 6GHz frequency range, at V_{CE} = 18V, I_C = 30mA.

Typical S-Parameters V_{CE} = 18V, I_C = 30mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.80	-19	20.6	10.7	165	-37	0.01	77	0.98	-8
200	0.78	-37	20.1	10.2	154	-31	0.03	67	0.94	-15
300	0.75	-53	19.5	9.44	143	-28	0.04	60	0.88	-21
400	0.72	-68	18.7	8.63	133	-27	0.05	53	0.83	-26
500	0.68	-81	17.9	7.87	124	-26	0.05	47	0.78	-30
600	0.66	-92	17.0	7.15	117	-25	0.06	42	0.73	-33
700	0.64	-102	16.2	6.52	110	-24	0.06	39	0.69	-36
800	0.62	-111	15.5	5.96	104	-24	0.07	36	0.66	-38
900	0.61	-119	14.8	5.49	99	-23	0.07	33	0.64	-41
1000	0.60	-126	14.1	5.08	94	-23	0.07	31	0.61	-43
1500	0.56	-151	11.2	3.64	75	-23	0.08	25	0.55	-51
2000	0.55	-169	8.9	2.80	59	-22	0.08	22	0.52	-61
2500	0.56	179	7.2	2.29	45	-21	0.09	21	0.53	-72
3000	0.55	168	5.7	1.93	33	-21	0.09	21	0.52	-79
3500	0.56	158	4.5	1.69	21	-20	0.10	20	0.55	-89
4000	0.54	148	3.5	1.50	10	-19	0.11	19	0.58	-96
4500	0.54	137	2.5	1.33	0	-19	0.11	18	0.58	-106
5000	0.52	128	1.6	1.21	-11	-18	0.13	16	0.62	-113
5500	0.54	115	1.0	1.12	-23	-17	0.14	14	0.60	-122
6000	0.54	108	0.0	1.01	-32	-17	0.15	11	0.64	-132

Typical S-Parameters V_{CE} = 15V, I_C = 15mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.80	-18	19.4	9.35	166	-37	0.01	78	0.98	-7
200	0.78	-35	19.1	9.07	155	-31	0.02	69	0.95	-14
300	0.76	-50	18.5	8.44	145	-28	0.03	61	0.91	-20
400	0.73	-64	17.8	7.79	135	-26	0.04	55	0.86	-25
500	0.69	-77	17.1	7.16	127	-25	0.05	49	0.81	-29
600	0.67	-88	16.3	6.56	119	-24	0.06	44	0.76	-32
700	0.64	-97	15.5	6.02	113	-23	0.06	40	0.72	-35
800	0.62	-107	14.8	5.54	107	-23	0.06	37	0.69	-38
900	0.60	-115	14.2	5.13	101	-23	0.07	34	0.66	-40
1000	0.60	-122	13.5	4.76	96	-23	0.07	32	0.63	-43
1500	0.57	-148	10.8	3.47	76	-22	0.08	24	0.57	-53
2000	0.55	-166	8.6	2.69	60	-21	0.08	21	0.54	-63
2500	0.56	-178	6.9	2.21	46	-21	0.09	19	0.55	-75
3000	0.56	171	5.1	1.80	36	-20	0.09	21	0.50	-85
3500	0.56	160	4.3	1.65	21	-20	0.10	18	0.56	-91
4000	0.53	151	3.3	1.47	10	-19	0.11	18	0.59	-99
4500	0.53	141	2.3	1.30	0	-19	0.11	17	0.59	-108
5000	0.50	130	1.5	1.18	-10	-18	0.12	15	0.62	-116
5500	0.52	118	0.8	1.10	-22	-17	0.14	13	0.61	-124
6000	0.53	110	0.0	0.99	-31	-16	0.15	11	0.64	-135

HEWLETT PACKARD

LINEAR POWER TRANSISTOR

HXTR-5102

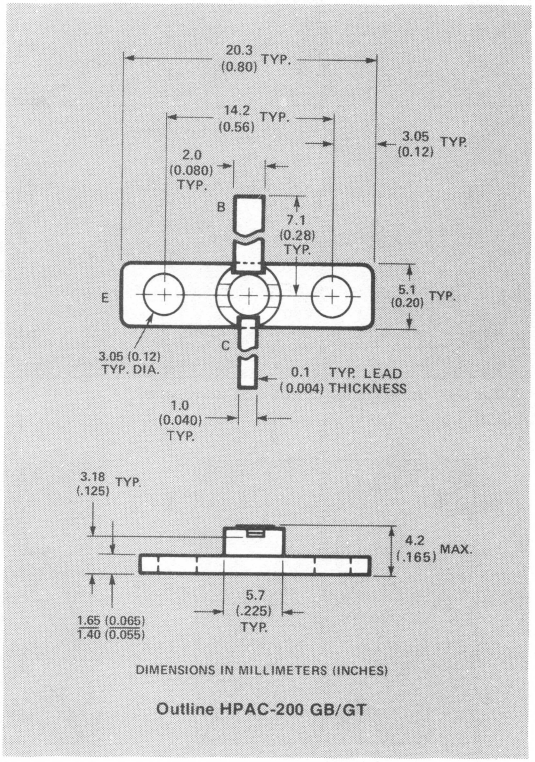
Features

HIGH OUTPUT POWER
- **29 dBm Typical P_{1dB} at 2 GHz**
- **27.5 dBm Typical P_{1dB} at 4 GHz**

HIGH P_{1dB} GAIN
- **11.5 dB Typical G_{1dB} at 2 GHz**
- **7 dB Typical G_{1dB} at 4 GHz**

HIGH POWER-ADDED EFFICIENCY

HERMETIC FLANGE PACKAGE



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-200 GB/GT

Description/Applications

The HXTR-5102 is an NPN bipolar transistor designed for high output power and gain up to 5 GHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes ion implantation and self-alignment techniques. The chip has a dielectric scratch protection over its active area and Ta_2N ballast resistors for ruggedness. A silicone conformal coating protects the chip and matching network.

The superior power, gain and distortion performance of the HXTR-5102 commend it for use in broad and narrowband commercial and military telecommunications, radar and ECM applications. Additionally, its partial internal matching makes it ideal for broad bandwidth designs in the 2 to 5 GHz frequency range with minimal sacrifice of output power and gain.

The HXTR-5102 is supplied in the HPAC-200GB/GT, a metal/ceramic hermetic package with a Be0 heat conductor, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings*

(T_{CASE} = 25°C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4V
I_C	DC Collector Current	250 mA
P_T	Total Device Dissipation	4W
T_J	Junction Temperature	200°C
T_{STG}	Storage Temperature	-65°C to 200°C
—	Lead Temperature (Soldering 10 seconds each lead)	+250°C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 35°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions		Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 10 mA		3001*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C = 50 mA		3011*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B = 100 μA		3026*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB} = 2 V		3061	μA			5
I_{CES}	Collector-Emitter Leakage Current at V_{CE} = 32 V		3041	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB} = 20 V		3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 18 V, I_C = 110 mA		3076*		15	40	75
P_{1dB}	Power Output at 1 dB Gain Compression	f = 2 GHz f = 4 GHz		dBm	 26.5	29.0 27.5	
G_{1dB}	Associated 1 dB Compressed Gain	f = 2 GHz f = 4 GHz		dB	 6.0	11.5 7.0	
P_{SAT}	Saturated Power Output (8 dB Gain) (3 dB Gain)	f = 2 GHz f = 4 GHz		dBm		31.0 29.5	
η	Power-Added Efficiency at 1 dB Compression	f = 2 GHz f = 4 GHz		%		37 23	
IP_3	Third Order Intercept Point, V_{CE} = 18 V, I_C = 110 mA			dBm		36	
C_{cb}	Reverse Transfer Capacitance I_C = 0 mA; V_{CB} = 10 V; f = 1 MHz			pF		0.73	

*300 μs wide pulse measurement, ≤2% duty cycle.

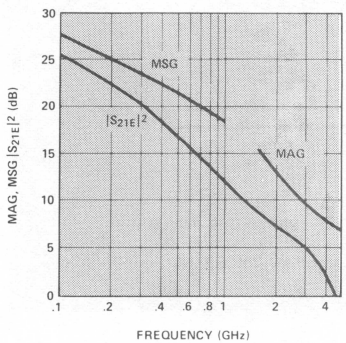


Figure 1. Typical MAG, Maximum Stable Gain (MSG) and $|S_{21E}|^2$ vs. Frequency at V_{CE} = 18 V, I_C = 110 mA.

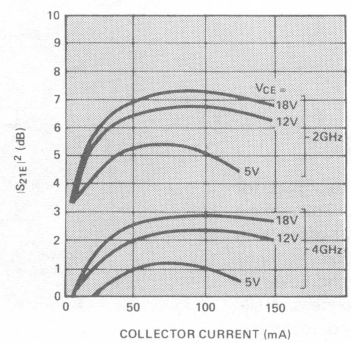


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 2 and 4 GHz.

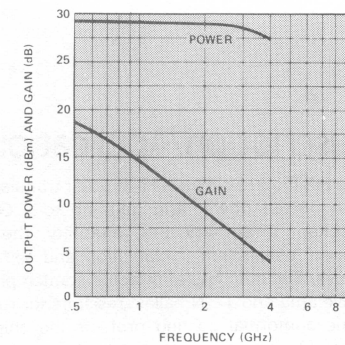


Figure 3. Typical P_{1dB} and Associated 1 dB Compressed Gain vs. Frequency at V_{CE} = 18 V, I_C = 110 mA.

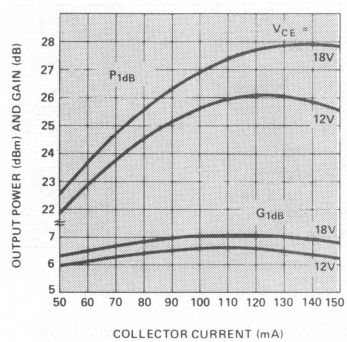


Figure 4. Typical P_{1dB} and Associated 1 dB Compressed Gain vs. Current at V_{CE} = 12 and 18 V at 4 GHz.

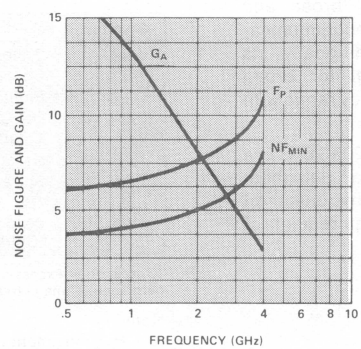


Figure 5. Typical Noise Figure NF_{MIN} and Associated Gain (G_A) when tuned for Minimum Noise vs. Frequency at V_{CE} = 18 V, I_C = 25 mA, Typical Noise Figure (F_D) when tuned for Max P_{1dB} at V_{CE} = 18 V, I_C = 110 mA.

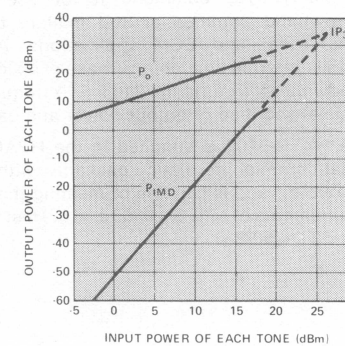


Figure 6. Typical Two Tone 3rd Order Intermodulation Distortion at 4 GHz for a frequency separation of 5 MHz at V_{CE} = 18 V, I_C = 110 mA.

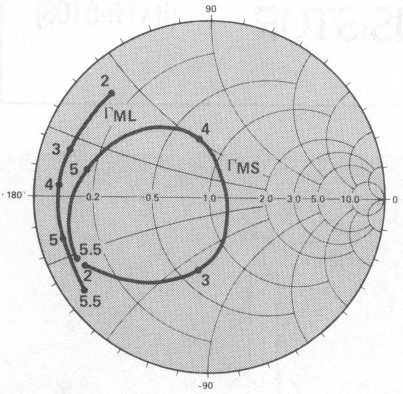


Figure 7. Typical Γ_{MS}, Γ_{ML} (calculated from the average S-parameters) in the 2 to 5.5GHz frequency range, for V_{CE} = 18V, I_C = 110mA.

Typical S-Parameters V_{CE} = 18 V, I_C = 110 mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.55	–74	25.4	18.60	146	–31	0.03	56	0.85	–29
200	0.65	–109	22.7	13.60	123	–28	0.04	39	0.68	–47
300	0.70	–134	20.8	10.90	108	–27	0.05	28	0.55	–59
400	0.72	–144	18.6	8.47	97	–26	0.05	21	0.48	–65
500	0.74	–158	17.2	7.22	88	–26	0.05	17	0.42	–74
600	0.73	–160	15.6	5.99	81	–25	0.05	13	0.41	–75
700	0.74	–167	14.6	5.39	76	–25	0.05	11	0.39	–79
800	0.74	–170	13.4	4.66	69	–25	0.06	8	0.39	–82
900	0.74	–175	12.7	4.32	64	–25	0.06	8	0.38	–86
1000	0.74	–178	11.8	3.91	59	–25	0.06	7	0.37	–92
1500	0.71	166	9.0	2.82	34	–24	0.06	–2	0.43	–107
2000	0.64	153	7.3	2.32	10	–23	0.07	–8	0.51	–119
2500	0.52	140	6.3	2.07	–17	–22	0.08	–22	0.61	–133
3000	0.32	129	5.4	1.86	–49	–21	0.09	–42	0.73	–148
3500	0.15	158	3.8	1.55	–83	–20	0.09	–67	0.77	–165
4000	0.32	–145	2.8	1.38	–113	–22	0.08	–98	0.80	–177
4500	0.52	–158	0.0	1.00	–142	–24	0.06	132	0.82	171
5000	0.70	176	–1.9	0.81	–170	–28	0.04	50	0.87	159
5500	0.78	155	–3.0	0.71	161	–28	0.04	85	0.83	142
6000	0.85	119	–3.9	0.64	121	–19	0.11	16	0.93	121

HEWLETT PACKARD

LINEAR POWER TRANSISTOR

2N6741 (HXTR-5103)

Features

HIGH OUTPUT POWER
- **23 dBm Typical P_{1dB} at 2 GHz**
- **22 dBm Typical P_{1dB} at 4 GHz**

HIGH P_{1dB} GAIN
- **11 dB Typical G_{1dB} at 2 GHz**
- **7 dB Typical G_{1dB} at 4 GHz**

HIGH POWER-ADDED EFFICIENCY

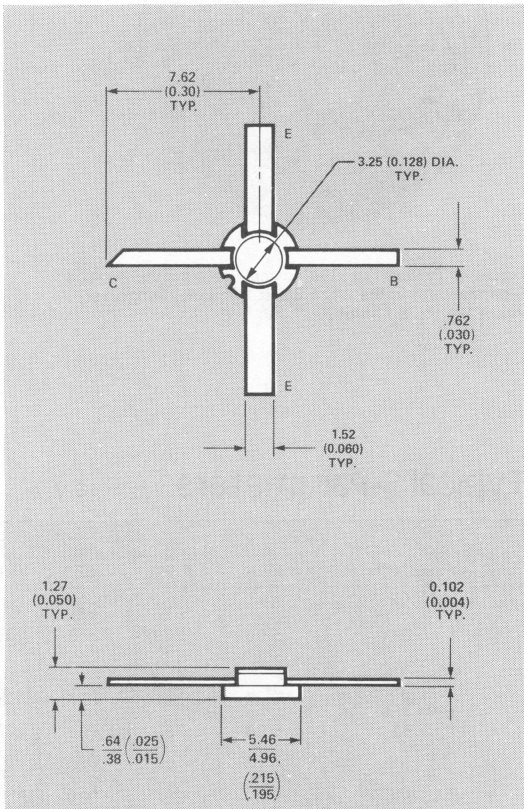
HERMETIC PACKAGE

Description/Applications

The HXTR-5103 is an NPN bipolar transistor designed for high gain and linear output power up to 5 GHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes ion implantation and self alignment techniques. The chip has a dielectric scratch protection over its active area and Ta_2N ballast resistors for ruggedness.

The superior power, gain and distortion performance of the HXTR-5103 commend it for use in RF and IF applications in radar, ECM, space, and other commercial and military communications.

The HXTR-5103 utilizes the HPAC-200, a metal/ceramic hermetic package with a Be0 heat conductor, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



ALL DIMENSIONS ARE IN MILLIMETERS (INCHES).

Outline HPAC-200

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4.0V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	1.4 W
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65°C to 200°C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 70° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C=3mA	3001*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C=15mA	3011*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B= 30μA	3026*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB}=2V	3061	μA			2
I_{CES}	Collector-Emitter Leakage Current at V_{CE}=32V	3041	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB}=20V	3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=18V, I_C=30mA	3076*		15	35	75
P_{1dB}	Power Output at 1dB Gain Compression f= 2GHz		dBm	22.0	23.0	
G_{1dB}	Associated 1dB Compressed Gain 2GHz		dB	9.5	11.0	
P_{SAT}	Saturated Power Output (Gain=5dB) 2GHz		dBm		25.0	
η	Power-Added Efficiency at 1dB Compression 2GHz		%		34	
IP_3	Third Order Intercept Point V_{CE}=18V, I_C=30mA 2GHz		dBm		32	

*300μs wide pulse measurement at ≤2% duty cycle.

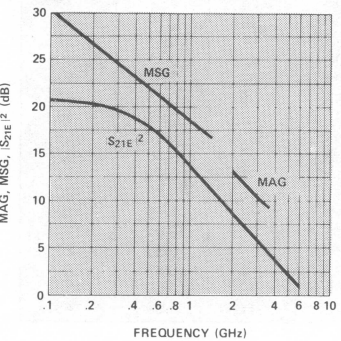


Figure 1. Typical MAG, Maximum Stable Gain MSG, and $|S_{21E}|^2$ vs. Frequency at V_{CE} = 18 V, I_C = 30 mA.

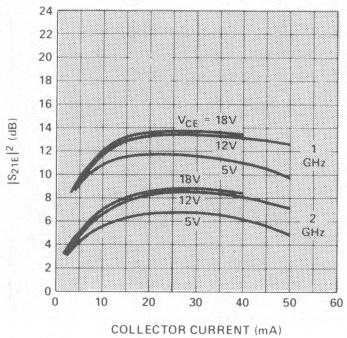


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1 and 2 GHz.

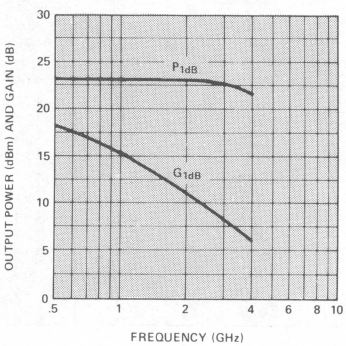


Figure 3. Typical P_{1dB} and Associated 1 dB Compressed Gain vs. Frequency at V_{CE} = 18 V, I_C = 30 mA.

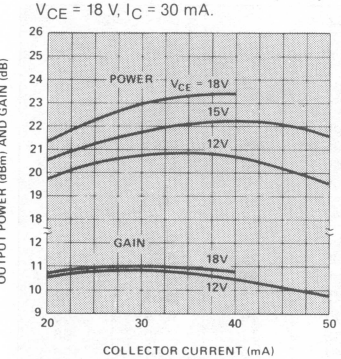


Figure 4. Typical P_{1dB} and Associated 1 dB Compressed Gain vs. Current at 2 GHz.

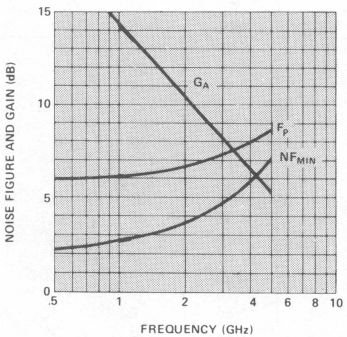


Figure 5. Typical Noise Figure NF_{MIN} and Associated Gain (G_A) vs. Frequency when tuned for Minimum Noise at V_{CE} = 18 V, I_C = 10 mA. Typical Noise Figure (F_P) when tuned for Max P_{1dB} at V_{CE} = 18 V, I_C = 30 mA.

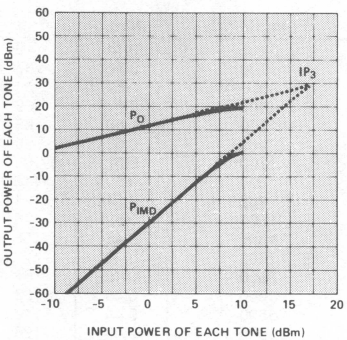


Figure 6. Typical Two Tone 3rd Order Intermodulation Distortion at 2 GHz for a frequency separation of 5 MHz at V_{CE} = 18 V, I_C = 30 mA.

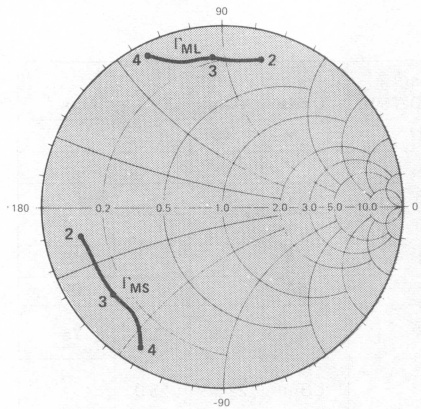


Figure 7. Typical Γ_{MS}, Γ_{ML} (Calculated from the Average S-Parameters) in the 2 to 4GHz Frequency Range for V_{CE} = 18V, I_C = 30mA.

Typical S-Parameters V_{CE} = 18V, I_C = 30mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.74	-20	20.7	10.90	165	-37	0.01	79	0.98	-9
200	0.71	-40	20.3	10.30	152	-32	0.03	68	0.94	-17
300	0.68	-57	19.6	9.49	140	-29	0.04	62	0.89	-23
400	0.65	-72	18.7	8.65	130	-27	0.04	55	0.84	-28
500	0.62	-86	17.8	7.77	121	-26	0.05	49	0.79	-33
600	0.60	-97	16.9	7.01	113	-25	0.06	44	0.75	-37
700	0.58	-108	16.2	6.43	106	-25	0.06	41	0.71	-40
800	0.55	-116	15.4	5.87	100	-24	0.06	38	0.68	-42
900	0.54	-124	14.6	5.38	94	-24	0.07	35	0.65	-44
1000	0.52	-131	13.8	4.91	88	-23	0.07	33	0.63	-46
1500	0.49	-159	11.0	3.53	66	-22	0.08	25	0.58	-59
2000	0.47	-179	8.8	2.77	48	-21	0.09	22	0.56	-67
2500	0.47	165	7.1	2.27	32	-20	0.10	18	0.56	-81
3000	0.45	151	5.8	1.95	17	-19	0.11	15	0.59	-90
3500	0.45	138	4.7	1.71	2	-18	0.12	10	0.59	-103
4000	0.42	123	3.7	1.54	-11	-17	0.14	4	0.64	-111
4500	0.41	110	3.2	1.44	-24	-16	0.16	1	0.65	-121
5000	0.39	89	2.2	1.29	-38	-15	0.17	-6	0.69	-131
5500	0.39	74	1.4	1.18	-53	-14	0.19	-12	0.69	-139
6000	0.37	55	0.7	1.09	-64	-13	0.22	-17	0.69	-148

Typical S-Parameters V_{CE} = 15V, I_C = 15mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.74	-19	19.1	9.05	164	-37	0.01	81	0.98	-8
200	0.70	-37	18.8	8.76	152	-31	0.03	68	0.94	-15
300	0.67	-54	18.2	8.16	141	-28	0.04	60	0.90	-21
400	0.63	-69	17.5	7.52	130	-27	0.05	53	0.85	-26
500	0.60	-83	16.8	6.90	121	-26	0.05	48	0.80	-31
600	0.58	-95	16.0	6.32	113	-25	0.06	43	0.76	-35
700	0.57	-105	15.2	5.78	107	-24	0.06	40	0.73	-38
800	0.55	-113	14.5	5.29	101	-24	0.07	37	0.70	-40
900	0.54	-121	13.8	4.88	95	-23	0.07	34	0.67	-43
1000	0.52	-128	13.0	4.48	89	-23	0.07	31	0.65	-45
1500	0.48	-156	10.2	3.23	66	-22	0.08	25	0.60	-55
2000	0.46	-177	8.0	2.51	48	-21	0.09	21	0.56	-65
2500	0.46	167	6.3	2.00	31	-20	0.10	18	0.57	-77
3000	0.45	153	5.0	1.78	16	-19	0.11	16	0.59	-86
3500	0.44	140	3.8	1.56	0	-18	0.12	12	0.60	-98
4000	0.43	126	2.8	1.38	-13	-17	0.14	8	0.64	-106
4500	0.41	112	1.9	1.24	-26	-16	0.15	4	0.64	-114
5000	0.38	93	1.0	1.12	-40	-15	0.17	-1	0.68	-123
5500	0.39	74	0.8	1.09	-55	-14	0.20	-6	0.70	-130
6000	0.37	56	-0.3	0.96	-67	-13	0.23	-12	0.69	-139

HEWLETT PACKARD

LINEAR POWER TRANSISTOR

HXTR-5104

Features

HIGH OUTPUT POWER
29 dBm Typical P_{1dB} at 2 GHz

HIGH P_{1dB} GAIN
9 dB Typical G_{1dB} at 2 GHz

LOW DISTORTION

HIGH POWER-ADDED EFFICIENCY

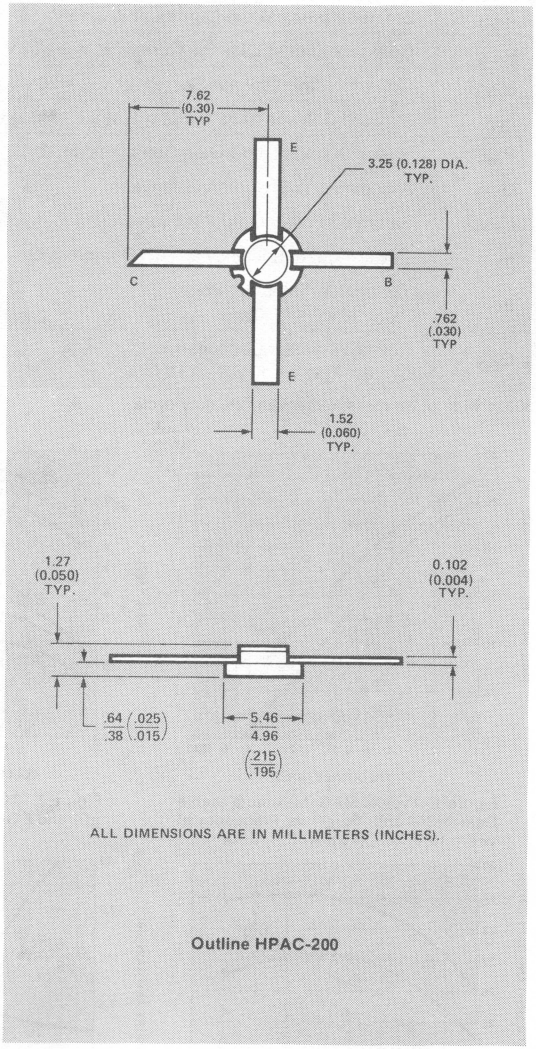
HERMETIC PACKAGE

Description/Applications

The HXTR-5014 is an NPN bipolar transistor designed for high gain and linear output power up to 4 GHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes ion implantation and self-alignment techniques. The chip has a dielectric scratch protection over its active area and Ta_2N ballast resistors for ruggedness.

The superior power, gain and distortion performance of the HXTR-5104 commend it for use in RF and IF applications in radar, ECM, space, and other commercial and military communications.

The HXTR-5104 utilizes the HPAC-200, a metal/ceramic hermetic package with a Be0 heat conductor, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



ALL DIMENSIONS ARE IN MILLIMETERS (INCHES).

Outline HPAC-200

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	45V
V_{CEO}	Collector to Emitter Voltage	27V
V_{EBO}	Emitter to Base Voltage	4V
I_C	DC Collector Current	250 mA
P_T	Total Device Dissipation	4 W
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	−65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
A Θ_{JC} maximum of 40° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions		Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 10 mA		3001*	V	40		
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C = 50 mA		3011*	V	24		
BV_{EBO}	Emitter-Base Breakdown Voltage at I_B = 100 μA		3026*	V	3.3		
I_{EBO}	Emitter-Base Leakage Current at V_{EB} = 2 V		3061	μA			10
I_{CES}	Collector-Emitter Leakage Current at V_{CE} = 32 V		3041	nA			200
I_{CBO}	Collector-Base Leakage Current at V_{CB} = 20 V		3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 18 V, I_C = 110 mA		3076*		15	40	75
P_{1dB}	Power Output at 1 dB Gain Compression	f = 2 GHz		dBm	28.0	29.0	
G_{1dB}	Associated 1 dB Compressed Gain	f = 2 GHz		dB	8.0	9.0	
P_{SAT}	Saturated Power Output (Gain = 5 dB)	f = 2 GHz		dBm		31.0	
η	Power-Added Efficiency at 1 dB Compression	f = 2 GHz		%		35	
IP_3	Third Order Intercept Point V_{CE} = 18 V, I_C = 110 mA	f = 2 GHz		dBm		37	
C_{cb}	Reverse Transfer Capacitance I_C = 0 mA; V_{CB} = 10 V; f = 1 MHz			pF		0.70	

*300μs wide pulse measurement at ≤2% duty cycle.

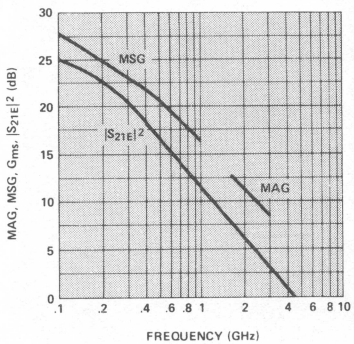


Figure 1. Typical MAG, Maximum Stable Gain (MSG) and $|S_{21E}|^2$ vs. Frequency at V_{CE} = 18 V, I_C = 110 mA.

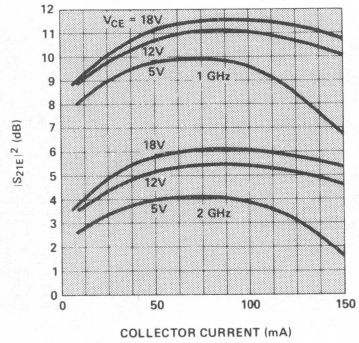


Figure 2. Typical $|S_{21E}|^2$ vs. Current at 1 and 2 GHz.

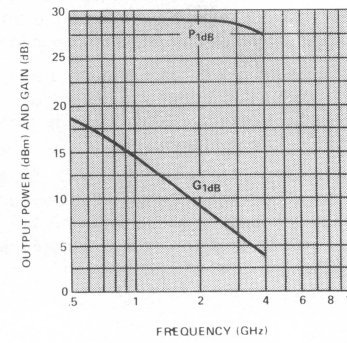


Figure 3. Typical P_{1dB} and Associated 1 dB Compressed Gain vs. Frequency at V_{CE} = 18 V, I_C = 110 mA.

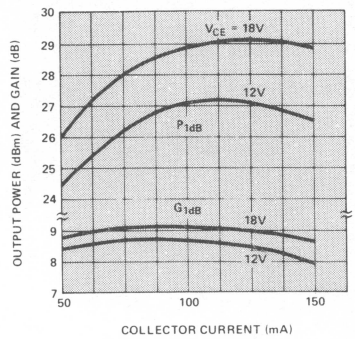


Figure 4. Typical P_{1dB} and Associated 1 dB Compressed Gain vs. Current at V_{CE} = 12 and 18 V at 2 GHz.

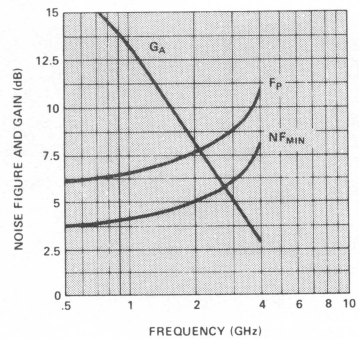


Figure 5. Typical Noise Figure NF_{MIN} and Associated Gain (G_A) vs. Frequency when tuned for Minimum Noise at V_{CE} = 18 V, I_C = 25 mA. Typical Noise Figure (F_P) when tuned for Max P_{1dB} at V_{CE} = 18 V, I_C = 110 mA.

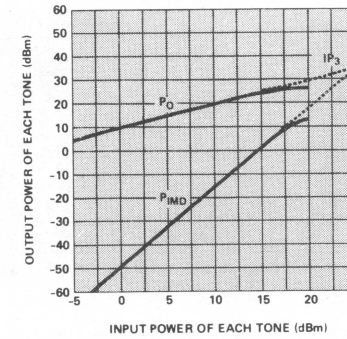


Figure 6. Typical Two Tone 3rd Order Intermodulation Distortion at 2 GHz for a frequency separation of 5 MHz at V_{CE} = 18 V, I_C = 110 mA.

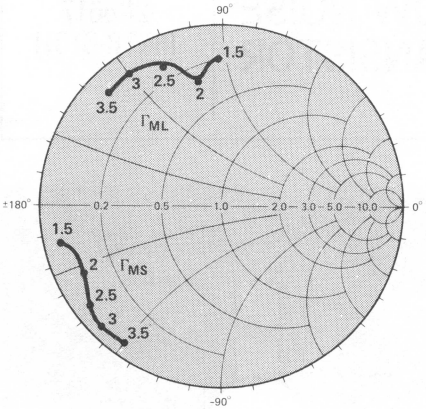


Figure 7. Typical Γ_{MS}, Γ_{ML} (calculated from the average S-parameters) in the 1.5 to 3.5GHz frequency range, at V_{CE} = 18V, I_C = 110mA.

Typical S-Parameters V_{CE} = 18V, I_C = 110mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.48	-68	24.8	17.30	140	-31	0.03	62	0.86	-27
200	0.54	-109	22.6	13.50	127	-27	0.04	48	0.69	-46
300	0.59	-132	20.4	10.50	112	-26	0.05	40	0.55	-58
400	0.61	-146	18.5	8.43	102	-25	0.06	36	0.47	-66
500	0.63	-155	16.9	7.02	94	-24	0.06	34	0.41	-71
600	0.64	-162	15.5	5.98	88	-24	0.06	33	0.38	-76
700	0.65	-168	14.3	5.21	83	-24	0.07	33	0.35	-80
800	0.65	-172	13.3	4.62	78	-23	0.07	33	0.34	-84
900	0.65	-176	12.4	4.15	73	-23	0.07	33	0.32	-87
1000	0.64	179	11.5	3.70	69	-22	0.08	32	0.32	-90
1500	0.65	169	8.2	2.57	50	-20	0.10	31	0.32	-104
2000	0.65	151	6.0	1.99	33	-19	0.11	30	0.33	-118
2500	0.66	139	4.3	1.64	17	-17	0.14	25	0.39	-130
3000	0.65	128	2.9	1.40	2	-16	0.16	20	0.42	-140
3500	0.64	115	1.8	1.23	-13	-15	0.19	14	0.46	-152
4000	0.63	103	0.9	1.11	-27	-13	0.22	5	0.51	-161
4500	0.61	87	0.2	1.03	-41	-12	0.26	-2	0.53	-172
5000	0.59	72	-0.7	0.93	-54	-11	0.29	-12	0.57	179
5500	0.58	53	-1.6	0.84	-67	-10	0.34	-22	0.57	167
6000	0.58	38	-2.3	0.77	-79	-9	0.37	-31	0.60	155

HEWLETT PACKARD

LOW NOISE TRANSISTOR

2N6617 (HXTR-6101)

Features

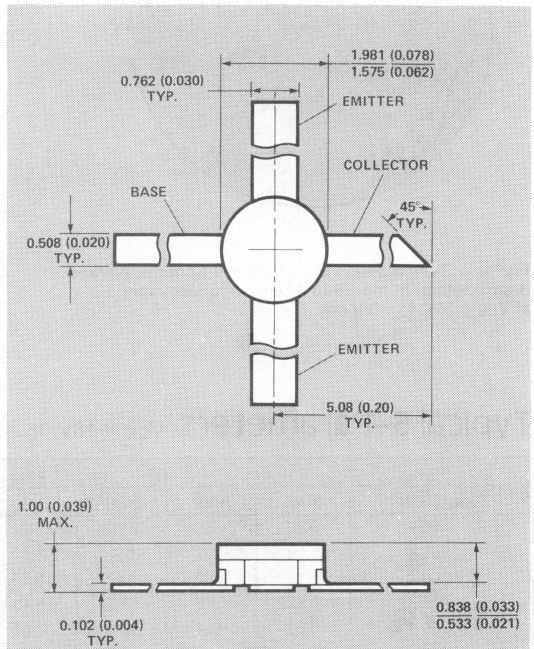
LOW NOISE FIGURE
2.8 dB Typical NF_{MIN} at 4 GHz

HIGH ASSOCIATED GAIN
9.0 dB Typical G_A at 4 GHz

HERMETIC PACKAGE

Description

The 2N6617 (HXTR-6101) is an NPN bipolar transistor designed for minimum noise figure. The device utlizies ion implantation techniques in its manufacture and the chip is also provided with scratch protection over its active area. The device is supplied in the HPAC-70GT, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



DIMENSIONS IN MILLIMETERS AND (INCHES).

Outline HPAC-70GT

Absolute Maximum Ratings *

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	35V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	20 mA
P_T	Total Device Dissipation	300 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 160° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE}=25°C

Symbol	Parameters And Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at I_C=100μA	3001*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=10V	3041	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB}=10V	3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=10V, I_C=4mA	3076*	–	50	100	250
NF_{MIN}	Minimum Noise Figure f = 2 GHz 4 GHz	3246	dB		1.6 2.8	3.0
G_A	Associated Gain f = 2 GHz 4 GHz Bias Conditions for Above: V_{CE} = 10V, I_C = 4mA		dB dB	8.0	13.5 9.0	
C_{cb}	Reverse Transfer Capacitance I_C = 0 mA; V_{CB} = 10 V; f = 1 MHz		pF		0.11	

*300μs wide pulse measurement at ≤2% duty cycle.

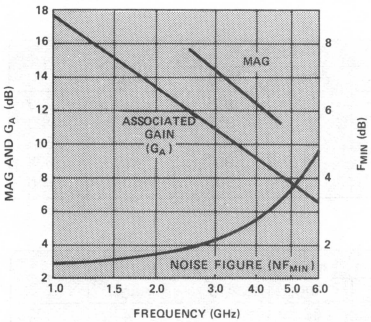


Figure 1. Typical MAG NF_{MIN} and Associated Gain vs. Frequency at V_{CE} = 10 V, I_C = 4 mA.

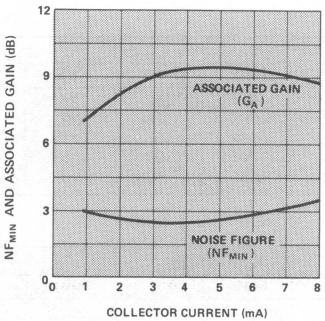


Figure 2. Typical NF_{MIN} and Associated Gain vs. I_C at 4 GHz V_{CE} = 10 V.

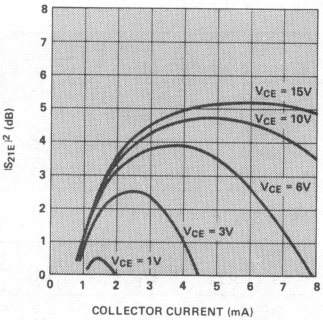


Figure 3. Typical $|S_{21E}|^2$ vs. Bias at 4 GHz.

Typical S-Parameters V_{CE} = 10V, I_C = 4mA

Freq. (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.91	-11	7.14	168	0.007	79	0.99	-4
500	0.78	-54	6.27	135	0.026	54	0.90	-18
1000	0.63	-98	5.03	113	0.037	33	0.78	-30
1500	0.59	-127	3.88	87	0.039	28	0.76	-35
2000	0.58	-149	3.14	71	0.042	26	0.75	-43
2500	0.57	-163	2.64	59	0.042	25	0.76	-50
3000	0.57	-173	2.20	48	0.043	25	0.77	-58
3500	0.56	180	1.94	37	0.046	25	0.79	-64
4000	0.54	173	1.66	29	0.049	24	0.81	-71
4500	0.53	167	1.45	20	0.053	24	0.85	-76
5000	0.51	160	1.34	11	0.058	23	0.86	-84
5500	0.50	152	1.21	1	0.060	22	0.88	-92
6000	0.48	146	1.07	-7	0.063	20	0.87	-99
7000	0.49	132	0.89	-23	0.069	15	0.87	-108

Typical Noise Parameters

V_{CE} = 10 V, I_C = 4 mA

Freq. (MHz)	Γ_o (Mag./Ang.)	R_N (Ohms)	NF_{MIN} (dB)
1000	.480/23°	23.31	1.45
1500	.450/61°	15.57	1.58
2000	.410/88°	15.73	1.72
3000	.425/121°	10.72	2.18
4000	.475/166°	3.50	2.75
5000	.530/-164°	2.81	3.67
6000	.520/-131°	7.23	4.78

Typical S-Parameters V_{CE} = 3V, I_C = 0.25mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}		K
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang	
500	.988	-22	-6.9	.451	152	-28.2	.039	72	.993	-12	.220
1000	.956	-42	-7.2	.438	127	-23.1	.070	55	.975	-22	.464
1500	.929	-65	-7.5	.423	106	-20.6	.093	38	.956	-33	.586
2000	.910	-81	-7.7	.412	89	-19.7	.104	27	.945	-42	.679
3000	.888	-112	-8.1	.394	56	-19.3	.108	6	.938	-59	.821

V_{CE} = 3V, I_C = 0.50mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}		K
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	
500	.976	-24	-0.8	.991	152	-28.4	.038	70	.986	-13	.220
1000	.929	-47	-1.3	.863	128	-23.6	.066	52	.955	-24	.423
1500	.887	-72	-2.0	.792	107	-21.4	.085	35	.920	-34	.583
2000	.856	-89	-2.5	.747	91	-20.6	.093	24	.906	-43	.682
3000	.818	-121	-3.3	.688	60	-20.1	.099	7	.889	-60	.816

V_{CE} = 3V, I_C = 1.0mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}		K
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	
500	.952	-25	4.4	1.67	149	-28.6	.037	66	.972	-14	.328
1000	.884	-54	3.7	1.54	125	-24.3	.061	47	.919	-25	.492
1500	.821	-82	2.7	1.36	104	-23.1	.070	31	.873	-36	.664
2000	.775	-102	1.9	1.25	88	-22.6	.074	23	.854	-43	.793
3000	.738	-133	.77	1.09	59	-22.1	.079	10	.842	-59	.908

HEWLETT PACKARD

LOW NOISE TRANSISTOR

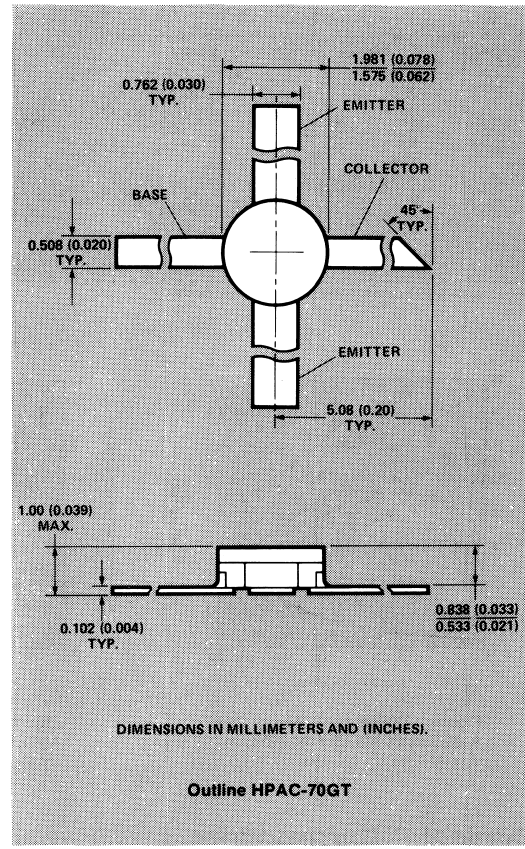
2N6742 (HXTR-6102)

Features

LOW NOISE FIGURE
2.8 dB Typical NF_{MIN} at 4 GHz

HIGH ASSOCIATED GAIN
9.0 dB Typical G_A

HERMETIC PACKAGE



Outline HPAC-70GT

Description

The 2N6742 (HXTR-6102) is an NPN bipolar transistor designed for minimum noise figure. The device utilizes ion implantation techniques in its manufacture and the chip is also provided with scratch protection over its active area. The device is supplied in the HPAC-70GT, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings *

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	35V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	20 mA
P_T	Total Device Dissipation	300 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 160° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE}=25°C

Symbol	Parameters And Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at I_C=100μA	3001*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=10V	3041	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB}=10V	3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=10V, I_C=4mA	3076*	–	50	150	250
NF_{MIN}	Minimum Noise Figure f = 2 GHz 4 GHz	3246	dB		1.6 2.5	2.7
G_A	Associated Gain f = 2 GHz 4 GHz Bias Conditions for Above: V_{CE} = 10V, I_C = 4mA		dB dB	8.0	13.5 9.0	

*300μs wide pulse measurement at ≤2% duty cycle.

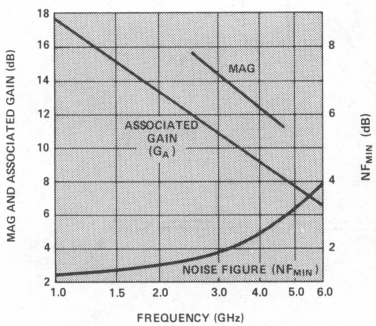


Figure 1. Typical MAG, NF_{MIN} and Associated Gain vs. Frequency at V_{CE} = 10 V, I_C = 4 mA.

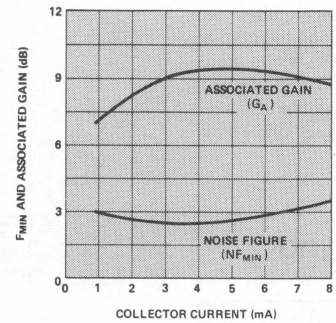


Figure 2. Typical NF_{MIN} and Associated Gain vs. I_C at 4 GHz for V_{CE} = 10 V (Tuned for NF_{MIN}).

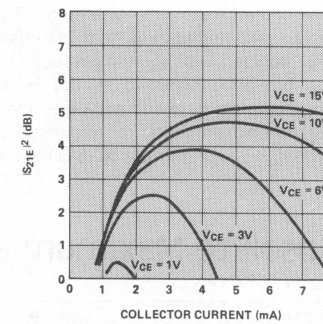


Figure 3. Typical $|S_{21E}|^2$ vs. Bias at 4 GHz.

Typical S-Parameters V_{CE} = 10 V, I_C = 4 mA

Freq. (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.917	-11	7.149	168	0.007	79	0.991	-4
500	0.782	-54	6.277	135	0.026	54	0.901	-18
1000	0.635	-98	5.037	113	0.037	33	0.787	-30
1500	0.598	-127	3.881	87	0.039	28	0.763	-35
2000	0.589	-149	3.148	71	0.042	26	0.754	-43
2500	0.570	-163	2.646	59	0.042	25	0.760	-50
3000	0.575	-173	2.203	48	0.043	25	0.773	-58
3500	0.560	180	1.948	37	0.046	25	0.795	-64
4000	0.548	173	1.665	29	0.049	24	0.816	-71
4500	0.530	167	1.450	20	0.053	24	0.850	-76
5000	0.518	160	1.346	11	0.058	23	0.860	-84
5500	0.500	152	1.210	1	0.060	22	0.880	-92
6000	0.489	146	1.076	-7	0.063	20	0.877	-99
7000	0.491	132	0.897	-23	0.069	15	0.872	-108

Typical Noise Parameters

V_{CE} = 10 V, I_C = 4 mA

Freq. (MHz)	Γ_o (Mag./Ang.)	R_N (Ohms)	NF_{MIN} (dB)
1000	.480/23°	23.31	1.45
1500	.450/61°	15.57	1.58
2000	.410/88°	15.73	1.72
3000	.425/121°	10.72	2.18
4000	.475/166°	3.50	2.75
5000	.530/-164°	2.81	3.67
6000	.520/-131°	7.23	4.78

Low Power Bias Performance

Bias					
V_{CE} V	I_C mA	NF_{MIN} dB	G_A dB	R_N Ohms	Γ_o Mag./Ang.
3	0.25	2.25	8.5	60.5	.805/31°
3	0.50	1.87	12.7	25.5	.713/38°
3	1.00	1.55	15.7	13.9	.571/39°

Figure 4. Noise Parameters at 1 GHz.

BIAS		Frequency							
		1000 MHz		1500 MHz		2000 MHz		3000 MHz	
V_{CE} V	I_C mA	NF_{MIN} dB	G_A dB	NF_{MIN} dB	G_A dB	NF_{MIN} dB	G_A dB	NF_{MIN} dB	G_A dB
3	0.25	2.25	8.5	2.67	5.0	2.83	4.7	3.88	4.1
3	0.50	1.87	12.7	2.06	9.9	2.23	7.9	2.93	6.4
3	1.0	1.55	15.7	1.73	11.7	1.79	10.2	2.38	8.1

Figure 5. Noise Performance vs. Frequency and Bias.

Typical S-Parameters V_{CE} = 3V, I_C = 0.25mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}		K
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang	
500	.988	-22	-6.9	.451	152	-28.2	.039	72	.993	-12	.220
1000	.956	-42	-7.2	.438	127	-23.1	.070	55	.975	-22	.464
1500	.929	-65	-7.5	.423	106	-20.6	.093	38	.956	-33	.586
2000	.910	-81	-7.7	.412	89	-19.7	.104	27	.945	-42	.679
3000	.888	-112	-8.1	.394	56	-19.3	.108	6	.938	-59	.821

V_{CE} = 3V, I_C = 0.50mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}		K
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	
500	.976	-24	-0.8	.991	152	-28.4	.038	70	.986	-13	.220
1000	.929	-47	-1.3	.863	128	-23.6	.066	52	.955	-24	.423
1500	.887	-72	-2.0	.792	107	-21.4	.085	35	.920	-34	.583
2000	.856	-89	-2.5	.747	91	-20.6	.093	24	.906	-43	.682
3000	.818	-121	-3.3	.688	60	-20.1	.099	7	.889	-60	.816

V_{CE} = 3V, I_C = 1.0mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}		K
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	
500	.952	-25	4.4	1.67	149	-28.6	.037	66	.972	-14	.328
1000	.884	-54	3.7	1.54	125	-24.3	.061	47	.919	-25	.492
1500	.821	-82	2.7	1.36	104	-23.1	.070	31	.873	-36	.664
2000	.775	-102	1.9	1.25	88	-22.6	.074	23	.854	-43	.793
3000	.738	-133	.77	1.09	59	-22.1	.079	10	.842	-59	.908

HEWLETT PACKARD

LOW NOISE TRANSISTOR

2N6618
(HXTR- 6103)

Features

GUARANTEED LOW NOISE FIGURE
2.2 dB Maximum NF_{MIN} at 2 GHz

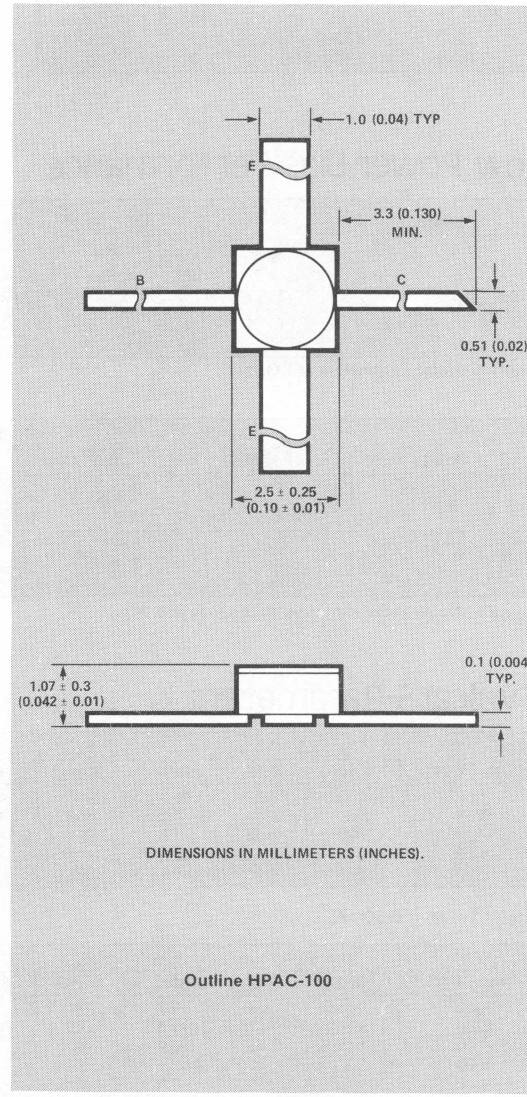
HIGH ASSOCIATED GAIN
12.0 dB Typical G_A at 2 GHz

HERMETIC PACKAGE

Description

The 2N6618 (HXTR-6103) is an NPN bipolar transistor designed for minimum noise figure at 2 GHz. The device utilizes ion implantation and self alignment techniques in its manufacture. The chip is provided with scratch protection over its active area.

These devices are supplied in the HPAC-100, a rugged metal/ceramic hermetic package, and are capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



DIMENSIONS IN MILLIMETERS (INCHES).

Outline HPAC-100

Absolute Maximum Ratings *

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	35V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	20 mA
P_T	Total Device Dissipation	300 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	−65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:

1. A Θ_{JC} maximum of 150°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters And Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CES}	Collector Emitter Breakdown Voltage at I_C = 100μA	3011*	V	30		
I_{CEO}	Collector Emitter Leakage Current at V_{CE} = 10 V	3041	nA			500
I_{CBO}	Collector Cut Off Current at V_{CB} = 10 V	3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 10 V, I_C = 3 mA	3076*	—	50	100	250
F_{MIN}	Minimum Noise Figure at 2 GHz	3246	dB		1.8	2.2
G_A	Associated Gain at 2 GHz Bias for above: V_{CE} = 10 V, I_C = 3 mA		dB	11.0	12.0	
C_{cb}	Reverse Transfer Capacitance I_C = 0 mA; V_{CB} = 10 V; f = 1 MHz		pF		0.14	

*300 μs wide pulse measurement at ≤ 2% duty cycle.

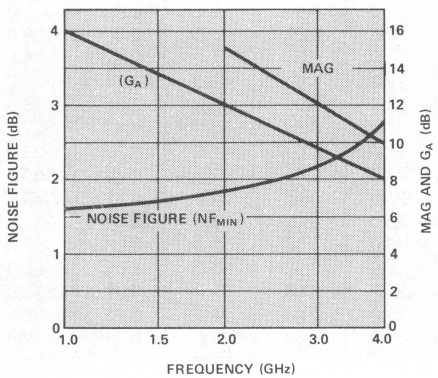


Figure 1. Typical MAG, NF_{MIN} and Associated Gain vs. Frequency at V_{CE} = 10 V, I_C = 3 mA.

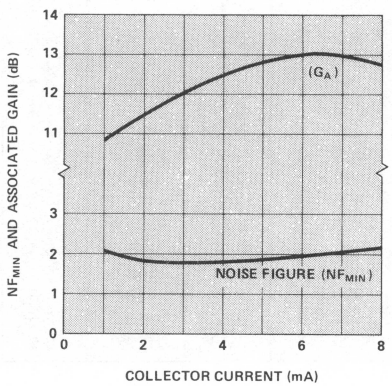


Figure 2. Typical NF_{MIN} and Associated Gain vs. Collector Current at 2 GHz for V_{CE} = 10 V (Tuned for NF_{MIN}).

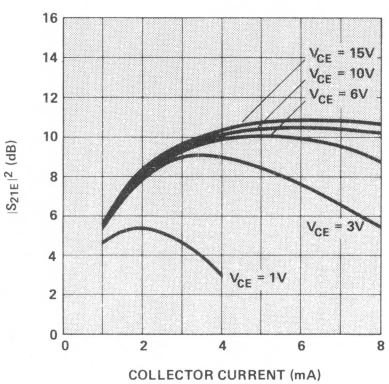


Figure 3. Typical $|S_{21E}|^2$ vs. Bias at 2 GHz.

Typical Noise Parameters

V_{CE} = 10 V, I_C = 3 mA

Freq. (MHz)	Γ_o (Mag./Ang.)	R_N (Ohms)	NF_{MIN} (dB)
1000	.465/36°	25.1	1.55
1500	.369/67°	22.5	1.65
2000	.323/94°	23.3	1.80

Typical S- Parameters V_{CE} = 10V, I_C = 3 mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.93	-11.5	16.2	6.46	168.0	-42.0	0.01	77.0	0.99	-4.0
200	0.89	-23.0	17.1	7.13	158.0	-37.0	0.01	77.0	0.97	-8.0
300	0.86	-34.0	16.4	6.58	149.0	-34.0	0.02	66.0	0.94	-12.0
400	0.83	-44.0	15.9	6.26	142.0	-32.0	0.03	60.0	0.92	-16.0
500	0.79	-54.0	15.6	6.02	135.0	-30.0	0.03	55.0	0.89	-19.0
600	0.75	-65.0	15.4	5.91	128.0	-29.0	0.04	51.0	0.87	-21.0
700	0.71	-73.0	15.0	5.62	121.0	-29.0	0.04	48.0	0.85	-24.0
800	0.68	-81.0	14.4	5.25	116.0	-28.0	0.04	45.0	0.84	-25.0
900	0.65	-91.0	14.0	4.99	111.0	-28.0	0.04	43.0	0.83	-27.0
1000	0.62	-97.0	13.5	4.72	106.0	-27.0	0.04	41.0	0.81	-28.0
1500	0.52	-129.0	11.4	3.71	84.0	-27.0	0.05	32.0	0.74	-35.0
2000	0.50	-151.0	9.3	2.93	69.0	-26.0	0.05	31.0	0.72	-43.0
2500	0.50	-169.0	7.8	2.45	55.0	-26.0	0.05	31.0	0.69	-51.0
3000	0.49	175.0	6.5	2.12	42.0	-26.0	0.06	33.0	0.68	-57.0
3500	0.54	165.0	5.4	1.87	29.0	-25.0	0.06	35.0	0.65	-68.0
4000	0.52	156.0	4.5	1.67	19.0	-24.0	0.06	37.0	0.68	-76.0
5000	0.53	140.0	2.6	1.35	-3.0	-23.0	0.08	35.0	0.71	-96.0
6000	0.48	120.0	0.9	1.11	-22.0	-21.0	0.09	34.0	0.73	-112.0

HEWLETT PACKARD

LOW NOISE TRANSISTOR

2N6743 (HXTR-6104)

Features

GUARANTEED LOW NOISE FIGURE
1.6 dB Maximum NF_{MIN} at 1.5 GHz

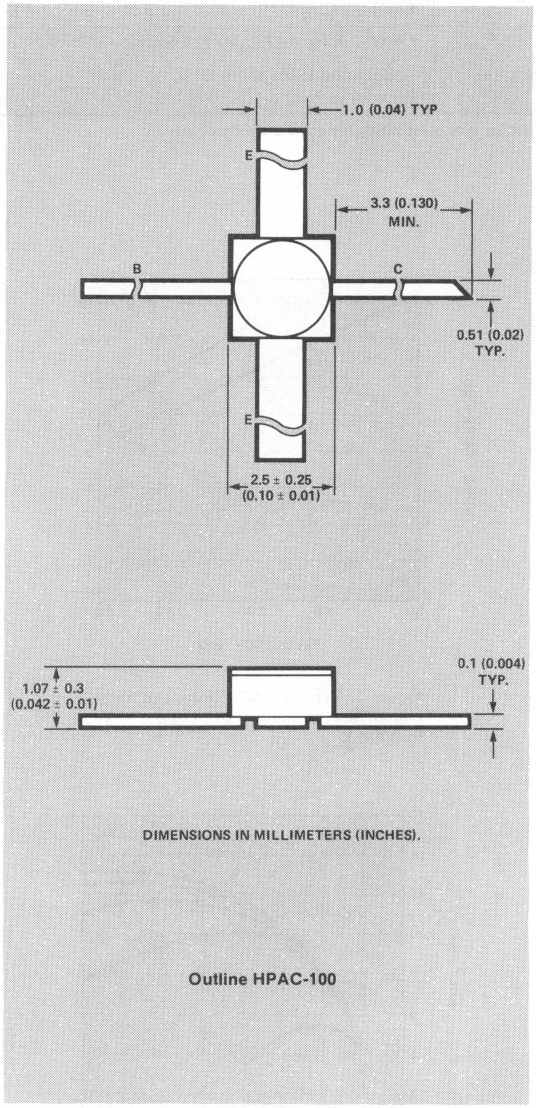
HIGH ASSOCIATED GAIN
14.0 dB Typical G_A at 1.5 GHz

HERMETIC PACKAGE

Description

The 2N6743 (HXTR-6104) is an NPN bipolar transistor designed for minimum noise figure at 1.5 GHz. The device utilizes ion implantation techniques and self alignment techniques in its manufacture. The chip is provided with scratch protection over its active area.

The 2N6743 (HXTR-6104) is supplied in the HPAC-100, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-100

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}[1]	Collector to Base Voltage	35V
V_{CEO}[1]	Collector to Emitter Voltage	20V
V_{EBO}[1]	Emitter to Base Voltage	1.5V
I_C[1]	DC Collector Current	20 mA
P_T[1]	Total Device Dissipation	300 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	–65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 150° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters And Test Conditions	Test MIL-STD-750	Units	Min.	Typ.	Max.
BV_{CES}	Collector Emitter Breakdown Voltage at I_C = 100μA	3011*	V	30		
I_{CEO}	Collector Emitter Leakage Current at V_{CE} = 10 V	3041	nA			500
I_{CBO}	Collector Cut Off Current at V_{CB} = 10 V	3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 10 V, I_C = 3 mA	3076*	—	50	100	250
NF_{MIN}	Minimum Noise Figure at 1.5 GHz	3246	dB		1.4	1.6
G_A	Associated Gain at 1.5 GHz Bias for above: V_{CE} = 10 V, I_C = 3 mA		dB	13.0	14.0	

*300 μs wide pulse measurement at ≤ 2% duty cycle.

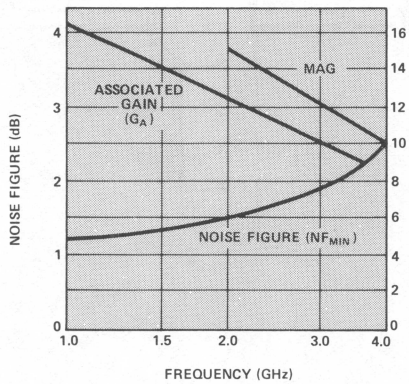


Figure 1. Typical MAG, NF_{MIN} and Associated Gain vs. Frequency at V_{CE} = 10 V, I_C = 3 mA.

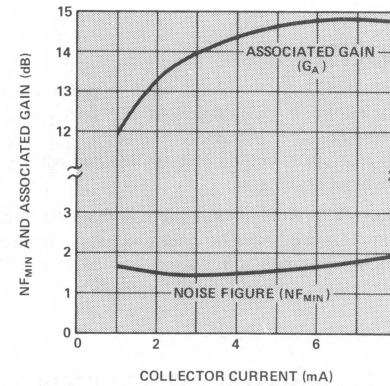


Figure 2. Typical Noise Figure and Associated Gain vs. I_C at 1.5 GHz for V_{CE} = 10 V (Tuned for NF_{MIN}).

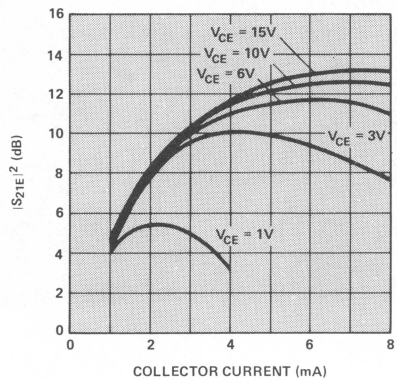


Figure 3. Typical $|S_{21E}|^2$ vs. Bias at 1.5 GHz.

Typical Noise Parameters

V_{CE} = 10 V, I_C = 3 mA

Freq. (MHz)	Γ_o (Mag./Ang.)	R_N (Ohms)	NF_{MIN} (dB)
1000	.465/36°	25.09	1.20
1500	.369/67°	22.47	1.40
2000	.323/94°	23.31	1.50

Typical S-Parameters V_{CE} = 10V, I_C = 3 mA

	S_{11}		S_{21}			S_{12}			S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.93	-11.5	16.2	6.46	168.0	-42.0	0.01	77.0	0.99	-4.0
200	0.89	-23.0	17.1	7.13	158.0	-37.0	0.01	77.0	0.97	-8.0
300	0.86	-34.0	16.4	6.58	149.0	-34.0	0.02	66.0	0.94	-12.0
400	0.83	-44.0	15.9	6.26	142.0	-32.0	0.03	60.0	0.92	-16.0
500	0.79	-54.0	15.6	6.02	135.0	-30.0	0.03	55.0	0.89	-19.0
600	0.75	-65.0	15.4	5.91	128.0	-29.0	0.04	51.0	0.87	-21.0
700	0.71	-73.0	15.0	5.62	121.0	-29.0	0.04	48.0	0.85	-24.0
800	0.68	-81.0	14.4	5.25	116.0	-28.0	0.04	45.0	0.84	-25.0
900	0.65	-91.0	14.0	4.99	111.0	-28.0	0.04	43.0	0.83	-27.0
1000	0.62	-97.0	13.5	4.72	106.0	-27.0	0.04	41.0	0.81	-28.0
1500	0.52	-129.0	11.4	3.71	84.0	-27.0	0.05	32.0	0.74	-35.0
2000	0.50	-151.0	9.3	2.93	69.0	-26.0	0.05	31.0	0.72	-43.0
2500	0.50	-169.0	7.8	2.45	55.0	-26.0	0.05	31.0	0.69	-51.0
3000	0.49	175.0	6.5	2.12	42.0	-26.0	0.06	33.0	0.68	-57.0
3500	0.54	165.0	5.4	1.87	29.0	-25.0	0.06	35.0	0.65	-68.0
4000	0.52	156.0	4.5	1.67	19.0	-24.0	0.06	37.0	0.68	-76.0
5000	0.53	140.0	2.6	1.35	-3.0	-23.0	0.08	35.0	0.71	-96.0
6000	0.48	120.0	0.9	1.11	-22.0	-21.0	0.09	34.0	0.73	-112.0

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR

HXTR-6105

Features

LOW NOISE FIGURE
4.2 dB Maximum NF_{MIN} at 4 GHz

HIGH ASSOCIATED GAIN
9 dB Typical G_A at 4 GHz

WIDE DYNAMIC RANGE

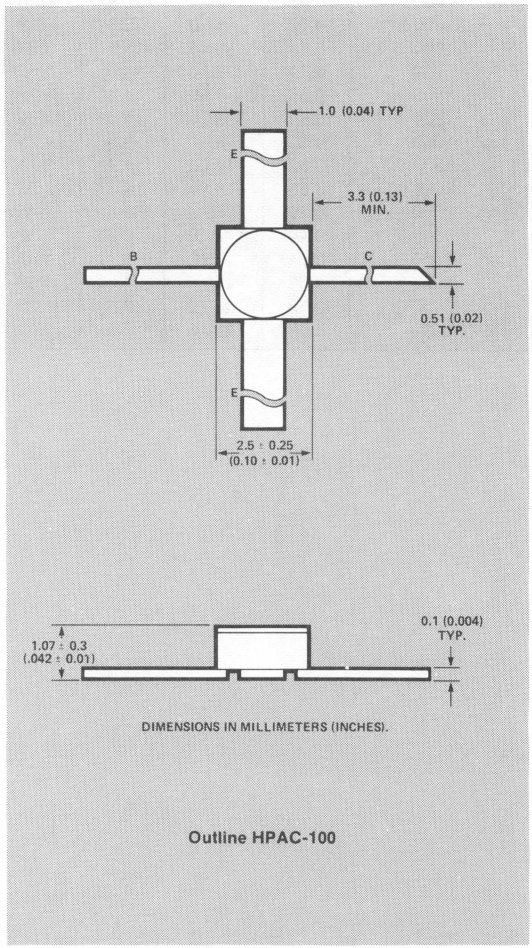
HERMETIC PACKAGE

Description

The HXTR-6105 is an NPN bipolar transistor designed for high gain up to 4 GHz with high output dynamic range. This transistor also features high output power and high gain at the NF bias and tuning conditions.

The device utilizes ion implantation techniques and self alignment techniques in its manufacture. The chip is provided with a dielectric scratch protection over its active area.

The HXTR-6105 is supplied in the HPAC-100, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-100

Absolute Maximum Ratings *

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 125° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage I_C=100μA	3011*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE}=15V	3041	nA			500
I_{CBO}	Collector Cut Off Current at V_{CB} = 15V	3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE}=15V, I_C=15mA	3076*	–	50	100	220
NF_{MIN}	Minimum Noise Figure f = 1.5 GHz = 4 GHz	3246	dB		2.2 4.0	 4.2
G_A	Associated Gain f = 1.5 GHz V_{CE} = 15V, I_C = 15mA = 4 GHz		dB	 8.0	15.0 9.0	
P_{1dB}	Power Output at 1dB Compression at 4 GHz V_{CE} = 15V, I_C = 15mA		dBm		14	

*300 μs wide pulse measurement at ≤ 2% duty cycle.

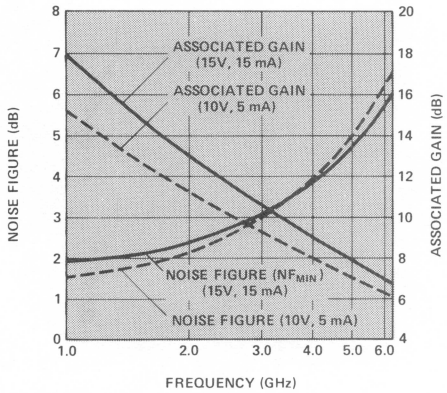


Figure 1. Typical NF_{MIN} and Associated Gain vs. Frequency.

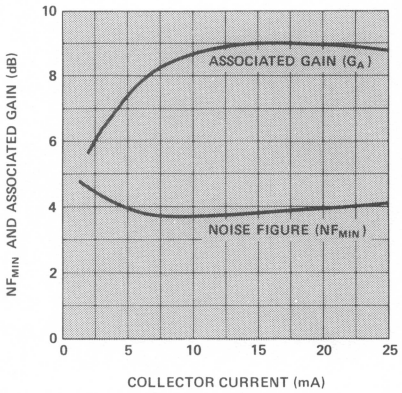


Figure 2. Typical NF_{MIN} and Associated Gain vs. I_C at 4 GHz for V_{CE} = 15 V (Tuned for NF_{MIN}).

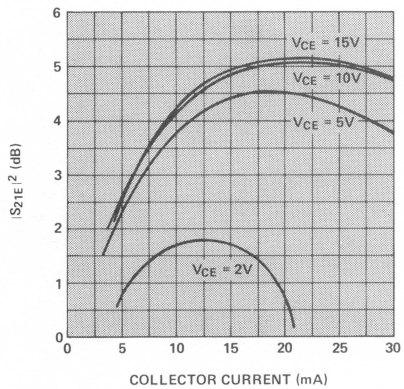


Figure 3. Typical $|S_{21E}|^2$ vs. Current at 4 GHz.

Typical Noise Parameters

V_{CE} = 15 V, I_C = 15 mA

Freq. (MHz)	Γ_o (Mag./Ang.)	R_N (Ohms)	NF_{MIN} (dB)
1000	.238/123°	6.81	1.80
1500	.385/142°	5.33	2.15
2000	.429/173°	5.04	2.25
3000	.541/-158°	6.54	3.01
4000	.628/-135°	15.54	3.81
5000	.624/-107°	60.14	4.75

Typical S-Parameters V_{CE} = 15V, I_C = 15mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.66	-52	29.0	28.3	152	-39.2	0.01	69	0.90	-16
500	0.59	-139	22.0	12.5	101	-37.7	0.03	41	0.55	-33
1000	0.59	-169	16.5	6.71	80	-29.6	0.03	45	0.47	-37
1500	0.59	177	13.1	4.54	65	-27.5	0.04	49	0.47	-41
2000	0.61	165	10.8	3.48	53	-25.5	0.05	50	0.47	-50
2500	0.60	159	8.8	2.75	43	-24.0	0.06	51	0.49	-61
3000	0.62	148	7.2	2.28	32	-22.7	0.07	52	0.50	-68
3500	0.62	141	5.7	1.93	21	-21.4	0.09	49	0.54	-80
4000	0.62	132	4.6	1.70	10	-20.0	0.10	47	0.57	-85
4500	0.60	126	3.5	1.50	0.0	-19.0	0.11	45	0.60	-94
5000	0.60	118	2.6	1.35	-9	-17.2	0.14	42	0.65	-102
5500	0.61	112	1.8	1.23	-20	-16.8	0.14	35	0.66	-112
6000	0.62	104	0.9	1.11	-29	-16.1	0.16	31	0.67	-122

HEWLETT PACKARD

GENERAL PURPOSE TRANSISTOR

HXTR-6106

Features

GUARANTEED LOW NOISE FIGURE
2.7 dB Maximum NF_{MIN} at 2 GHz

HIGH ASSOCIATED GAIN
11.5 dB Typical G_A at 2 GHz

WIDE DYNAMIC RANGE

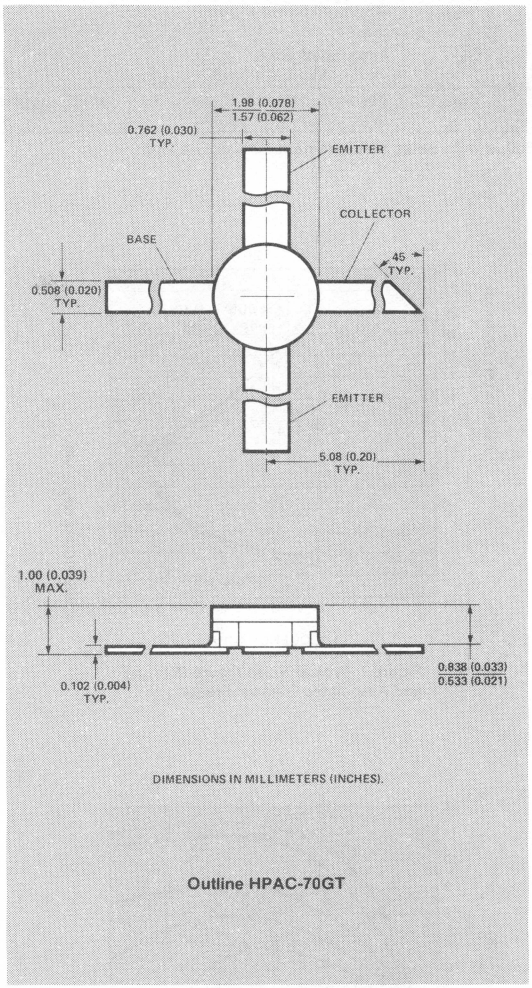
HERMETIC PACKAGE

Description

The HXTR-6106 is an NPN bipolar transistor designed for low noise up to 6 GHz with wide dynamic range. This transistor also features high output power and high gain at the NF bias and tuning conditions.

The device utilizes ion implantation and self alignment techniques in its manufacture and the chip is provided with a dielectric scratch protection over its active area.

The HXTR-6106 is supplied in the HPAC-70GT, a rugged metal/ceramic hermetic package, and is capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline HPAC-70GT

Absolute Maximum Ratings *

(T_{CASE} = 25° C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30V
V_{CEO}	Collector to Emitter Voltage	20V
V_{EBO}	Emitter to Base Voltage	1.5V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:
1. A Θ_{JC} maximum of 130° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at T_{CASE} = 25°C

Symbol	Parameters and Test Conditions		MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CES}	Collector-Emitter Breakdown Voltage at I_C = 100μA		3011*	V	30		
I_{CEO}	Collector-Emitter Leakage Current at V_{CE} = 15V		3041	nA			500
I_{CBO}	Collector Cutoff Current at V_{CB} = 15V		3036	nA			100
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 15V, I_C = 15mA		3076*	—	50	100	220
NF_{MIN}	Minimum Noise Figure	f=2 GHz 4 GHz	3246	dB		2.5 4.0	2.7
G_A	Associated Gain V_{CE} = 15V, I_C = 10 mA	f=2 GHz 4 GHz			10.0	11.5 9.0	
P_{1dB}	Associated Output Power at 1dB Gain Compression V_{CE} = 15V, I_C = 10mA	f=2 GHz		dBm		15	

*300μs wide pulse measurement ≤2% duty cycle.

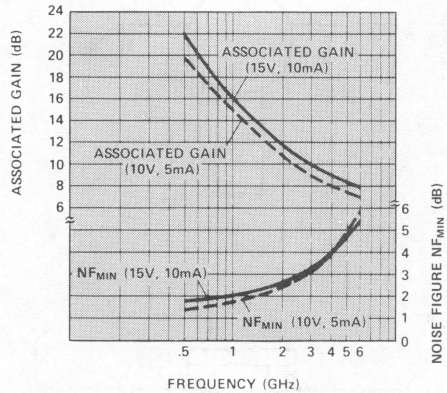


Figure 1. Typical Noise Figure (NF_{MIN}) and Associated Gain vs. Frequency.

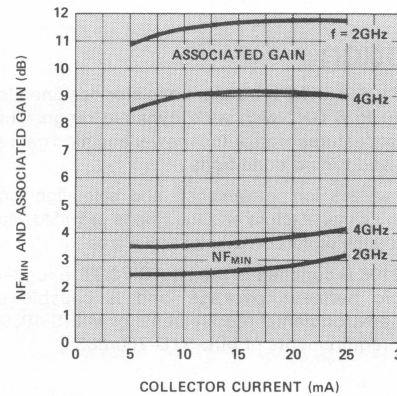


Figure 2. Typical Noise Figure (NF_{MIN}) and Associated Gain vs. Current at 2 GHz and 4 GHz at V_{CE} = 15 V.

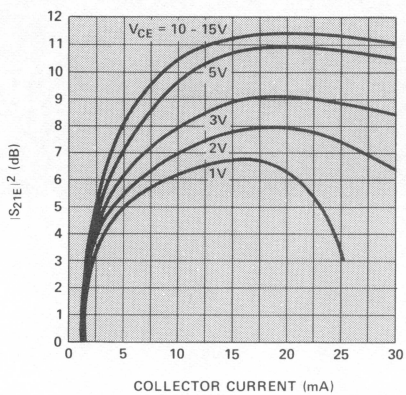


Figure 3. Typical $|S_{21E}|^2$ vs. Current at 2 GHz.

Typical Noise Parameters

Freq. (GHz)	NF_{MIN} (dB)	G_A (dB)	Γ_o	R_N(Ohms)
1.0	1.8	14.3	.10/60	48.9
1.5	2.1	13.3	.27/132	19.1
2.0	2.4	11.6	.46/156	9.9
3.0	3.4	8.9	.53/167	8.4
4.0	4.3	6.9	.61/174	6.4

Figure 4. Typical Noise Parameters at V_{CE} = 10V, I_C = 5mA.

Typical S-Parameters V_{CE} = 15V, I_C = 10mA

Freq. (MHz)	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag.	Ang.	(dB)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.
100	0.77	-36	26.4	20.8	157	-38.4	0.012	67	0.93	-12
200	0.72	-70	25.6	19.0	139	-34.0	0.020	55	0.82	-21
300	0.70	-95	24.1	16.0	125	-32.0	0.025	46	0.71	-26
400	0.70	-113	22.7	13.6	115	-31.0	0.028	41	0.64	-29
500	0.69	-126	21.3	11.6	108	-30.5	0.030	37	0.59	-31
600	0.68	-136	20.1	10.1	102	-29.9	0.032	36	0.56	-33
700	0.67	-143	19.0	8.9	97	-29.6	0.033	35	0.54	-34
800	0.66	-149	18.0	7.9	93	-29.4	0.034	35	0.54	-35
900	0.66	-154	17.0	7.0	91	-29.1	0.035	34	0.53	-36
1000	0.66	-159	16.1	6.4	86	-28.9	0.036	35	0.53	-36
1500	0.68	-174	12.8	4.3	72	-27.0	0.040	36	0.48	-41
2000	0.66	177	10.5	3.3	61	-27.1	0.044	40	0.50	-51
2500	0.66	169	8.5	2.6	50	-26.2	0.049	42	0.50	-60
3000	0.67	163	7.0	2.2	39	-25.0	0.056	44	0.54	-67
3500	0.69	156	5.6	1.9	31	-24.1	0.062	46	0.54	-77
4000	0.68	152	4.5	1.7	21	-23.1	0.070	46	0.60	-85
4500	0.69	142	3.6	1.5	12	-22.2	0.078	47	0.60	-92
5000	0.71	138	2.5	1.3	4	-21.2	0.087	46	0.62	-102
5500	0.70	130	1.8	1.2	-5	-20.5	0.094	42	0.66	-111
6000	0.76	124	0.9	1.1	-13	-19.7	0.103	42	0.67	-120
6500	0.71	121	0.0	1.0	-23	-19.1	0.111	38	0.75	-129

HEWLETT PACKARD

LOW NOISE, HIGH PERFORMANCE TRANSISTOR

HXTR-7111

Features

GUARANTEED NOISE FIGURE
3.4 dB Maximum NF_{MIN} at 4 GHz

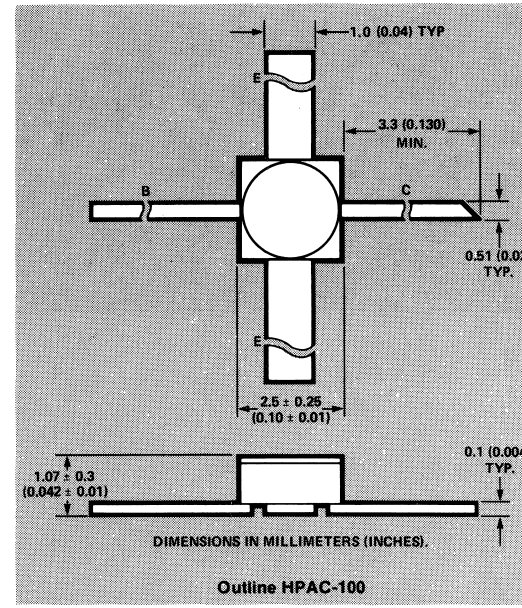
GUARANTEED ASSOCIATED GAIN
8.1 dB Minimum G_A at 4 GHz

HIGH OUTPUT POWER
18.5 dBm Typical P_{1dB} at 4 GHz

HIGH P_{1dB} GAIN
9.1 dB Typical G_{1dB} at 4 GHz

HIGH GAIN BANDWIDTH PRODUCT
6.0 GHz Typical f_T

HERMETIC PACKAGE



Outline HPAC-100

Description

The HXTR-7111 is an NPN silicon bipolar transistor designed for use in low noise wide band amplifier or medium power oscillation applications requiring superior VHF, UHF, or microwave performance. Excellent device uniformities, performance, and reliability are produced by the ion implantation and self alignment techniques used in the fabrication of these devices. The chip is provided with scratch protection over its active area.

The HXTR-7111 is supplied in the HPAC-100, a rugged hermetic metal-ceramic package capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.

Absolute Maximum Ratings*

(T_{CASE} = 25° C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	−65° C to 200° C
—	Lead Temperature (Soldering 10 seconds each lead)	+250° C

*Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:
1. A Θ_{JC} maximum of 120° C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Electrical Specifications at $T_{CASE} = 25°C$

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Typ.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at $I_C = 100\ \mu A$	3001*	V	30		
BV_{CEO}	Collector-Emitter Breakdown Voltage at $I_C = 15$ mA	3011*	V	18		
I_{CBO}	Collector-Base Cutoff Current at $V_{CB} = 15$ V	3036	nA			50
I_{CEO}	Collector-Emitter Leakage Current at $V_{CE} = 15$ V	3041	nA			50
h_{FE}	Forward Current Transfer Ratio at $V_{CE} = 10$ V, $I_C = 10$ mA	3076		55		175
f_T	Gain Bandwidth Product at $V_{CE} = 10$ V, $I_C = 10$ mA		GHz		6.0	
NF_{MIN}	Minimum Noise Figure $V_{CE} = 10$ V, $I_C = 10$ mA f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246	dB		 1.2 1.7 2.8	 3.4
G_A	Associated Gain $V_{CE} = 10$ V, $I_C = 10$ mA f = 1000 MHz f = 2000 MHz f = 4000 MHz	3246	dB	 8.1	 18.5 13.8 8.7	
P_{1dB}	Power Output at 1 dB Gain Compression at 4000 MHz Compression, $V_{CE} = 15$ V, $I_C = 18$ mA,		dBm		18.5	
G_{1dB}	Associated 1 dB Compressed Gain at 4000 MHz $V_{CE} = 15$ V, $I_C = 18$ mA		dB		9.1	
C_{cb}	Reverse Transfer Capacitance f = 1 MHz $V_{CB} = 10$ V, $I_C = 0$ mA		pF		0.27	

*300 μs wide pulse measurement ≤ 2% duty cycle.

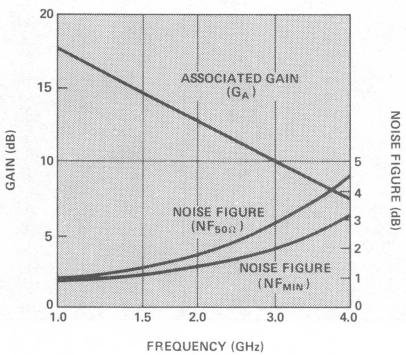


Figure 1. Typical Noise Figure and Associated Gain vs. Frequency at V_{CE} = 10 V, I_C = 10 mA.

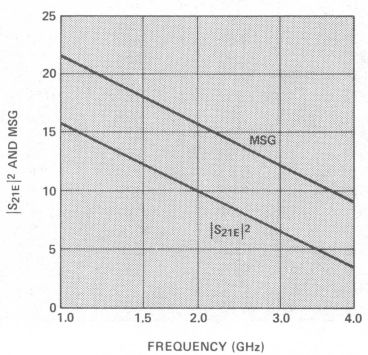


Figure 2. Typical $|S_{21E}|^2$ and Maximum Stable Gain (MSG) vs. Frequency at V_{CE} = 10 V and I_C = 10 mA.

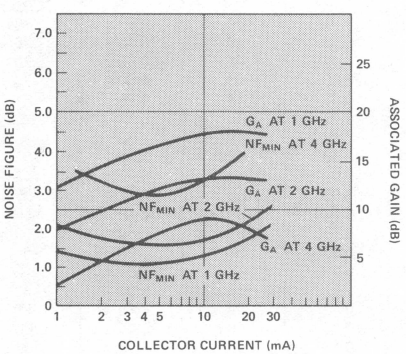


Figure 3. Typical NF_{MIN} and Associated Gain (G_A) vs. Collector Current at V_{CE} = 10 V.

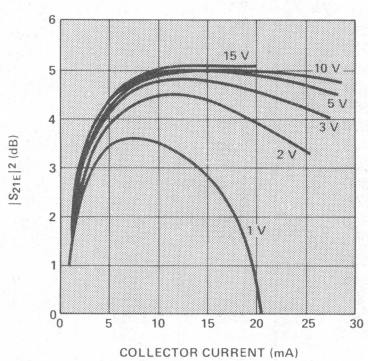


Figure 4. Typical $|S_{21E}|^2$ vs. Current at 4000 MHz.

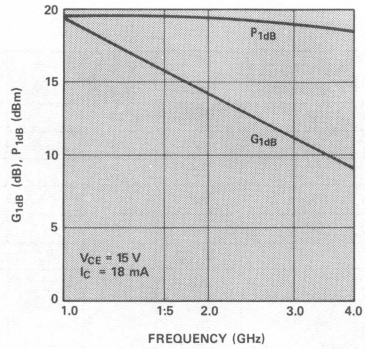


Figure 5. Typical Power Output at 1 dB Compression Gain vs. Frequency.

Typical Noise Parameters

V_{CE} = 10 V, I_C = 10 mA

Frequency (MHz)	NF_{MIN} (dB)	G_A (dB)	Γ_o Mag.	Γ_o Ang.	R_N (Ohms)
1000	1.2	18.5	0.22	141	2.6
2000	1.7	13.8	0.43	174	3.3
4000	2.8	8.7	0.57	-138	11.6

Typical S-Parameters (V_{CE} = 10 V, I_C = 10 mA)

	S_{11}		S_{21}			S_{12}		S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.68	-46	27.8	24.6	154	0.02	63	0.93	-15
200	0.64	-78	26.1	20.2	135	0.02	56	0.80	-26
300	0.65	-105	24.4	16.5	121	0.03	47	0.70	-32
400	0.63	-120	22.7	13.6	113	0.03	43	0.63	-34
500	0.62	-131	21.1	11.4	106	0.03	39	0.58	-35
600	0.61	-140	19.7	9.7	100	0.03	43	0.54	-36
700	0.61	-148	18.6	8.5	95	0.04	43	0.52	-36
800	0.60	-154	17.5	7.5	90	0.04	43	0.50	-37
900	0.61	-160	16.6	6.8	86	0.04	43	0.48	-40
1000	0.61	-164	15.7	6.1	83	0.04	43	0.47	-41
1500	0.61	-178	12.4	4.2	68	0.05	49	0.46	-50
2000	0.61	171	10.1	3.2	57	0.06	56	0.47	-57
2500	0.62	164	8.2	2.6	45	0.07	60	0.49	-68
3000	0.63	156	6.8	2.2	34	0.09	61	0.52	-75
3500	0.63	149	5.5	1.9	24	0.11	61	0.54	-85
4000	0.62	141	4.5	1.7	14	0.13	59	0.57	-93
4500	0.61	132	3.5	1.5	5	0.15	57	0.57	-102
5000	0.60	123	2.7	1.4	-4	0.18	53	0.62	-110
5500	0.61	112	2.0	1.3	-14	0.21	48	0.63	-118
6000	0.62	103	1.2	1.2	-22	0.23	43	0.67	-131
6500	0.62	93	0.5	1.1	-31	0.26	36	0.71	-140

Typical S-Parameters (V_{CE} = 15 V, I_C = 18 mA)

	S_{11}		S_{21}			S_{12}		S_{22}	
Freq. (MHz)	Mag.	Ang.	(dB)	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.63	-59	29.7	30.6	149	0.01	64	0.90	-18
200	0.61	-95	27.4	23.5	129	0.02	46	0.75	-26
300	0.62	-119	25.3	18.3	115	0.02	48	0.65	-30
400	0.62	-133	23.4	14.7	107	0.02	43	0.60	-31
500	0.61	-143	21.7	12.1	101	0.03	48	0.56	-31
600	0.60	-151	20.2	10.2	95	0.03	44	0.53	-32
700	0.60	-157	19.0	8.9	91	0.03	49	0.52	-32
800	0.60	-162	17.8	7.8	87	0.03	49	0.50	-32
900	0.60	-167	16.9	7.0	83	0.03	51	0.49	-35
1000	0.60	-170	16.0	6.3	81	0.03	51	0.48	-35
1500	0.61	177	12.7	4.3	67	0.04	60	0.48	-46
2000	0.61	168	10.4	3.3	55	0.06	65	0.50	-53
2500	0.62	161	8.3	2.6	44	0.07	67	0.52	-64
3000	0.63	153	6.9	2.2	33	0.09	68	0.54	-72
3500	0.63	147	5.6	1.9	23	0.11	66	0.56	-83
4000	0.62	139	4.6	1.7	13	0.13	64	0.60	-89
4500	0.62	130	3.5	1.5	4	0.15	60	0.60	-100
5000	0.60	121	2.9	1.4	-5	0.18	56	0.65	-106
5500	0.62	110	2.3	1.3	-16	0.21	52	0.65	-116
6000	0.63	102	1.6	1.2	-24	0.23	46	0.70	-128
6500	0.63	91	0.8	1.1	-33	0.26	40	0.74	-137

High Reliability Silicon Bipolar Transistors

- 2N6679TX and TXV (HXTR-2101TX and TXV) ... 3-112
  HXTR-2102TX and TXV ... 3-112
  HXTR-6016TX and TXV ... 3-112
- HXTR-3101TX and TXV ... 3-116
  2N6838TX and TXV (HXTR-3103TX and TXV) ... 3-116
- HXTR-3102TX and TXV ... 3-120
  2N6839TX and TXV (HXTR-3104TX and TXV) ... 3-120
- HXTR-3615TX and TXV ... 3-124
  HXTR-3645TX and TXV ... 3-124
  HXTR-3675TX and TXV ... 3-124
- HXTR-4101TX and TXV ... 3-128
  HXTR-4103TX and TXV ... 3-128
  HXTR-4104TX and TXV ... 3-128
  HXTR-4105TX and TXV ... 3-128
- 2N6701TX and TXV (HXTR-5101TX and TXV)
  HXTR-5102TX and TXV ... 3-134
  2N6741TX and TXV (HXTR-5103TX and TXV) ... 3-134
  HXTR-5104TX and TXV ... 3-134
- 2N6617TX and TXV (HXTR-6101TX and TXV) ... 3-139
  2N6742TX and TXV (HXTR-6102TX and TXV) ... 3-139
  2N6618TX and TXV (HXTR-6103TX and TXV) ... 3-139
  2N6743TX and TXV (HXTR-6104TX and TXV) ... 3-139
- HXTR-7111TX and TXV ... 3-143

HEWLETT PACKARD

HIGH RELIABILITY GENERAL PURPOSE TRANSISTORS

2N6679TX and TXV*
(HXTR-2101TX and TXV)
HXTR-2102TX and TXV
HXTR-6105TX and TXV
HXTR-6106TX and TXV

Features

HIGH GAIN

LOW NOISE FIGURE AND HIGH ASSOCIATED GAIN

WIDE DYNAMIC RANGE

HERMETIC PACKAGES

Description

These general purpose NPN bipolar transistors are designed for high gain and low noise up to 4 GHz with a wide dynamic range. The devices utilize ion implantation and self-alignment techniques in their manufacture. The common chip is provided with a dielectric scratch protection over its active area.

The HXTR-2101TX and TXV and HXTR-6105TX and TXV are supplied in the HPAC-100, while the HXTR-2102TX and TXV and HXTR-6106TX and TXV are supplied in the HPAC-70GT. Both packages are rugged, metal ceramic hermetic packages and are capable of meeting the requirements of MIL-S-19500 and the test requirements of MIL-STD-750.

Absolute Maximum Ratings†

(T_{CASE} = 25°C)

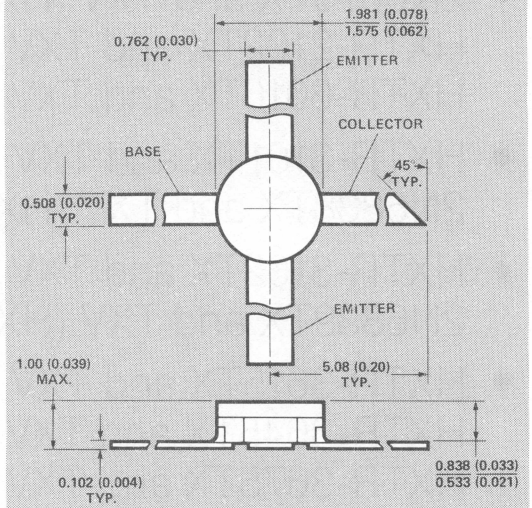
Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	20 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	900 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65°C to +200°C
—	Lead Temperature Soldering 10 seconds each lead	+250°C

†Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. For the 2N6679TX and TXV (HXTR-2101TX and TXV) and the HXTR-6105TX and TXV, a Θ_{JC} max of 125°C/W should be used for derating. For the HXTR-2102TX and TXV and HXTR-6106TX and TXV a Θ_{JC} max of 130°C/W should be used for derating. These Θ_{JC} values should be used for junction temperature calculations.
   $T_J = (P_D \times \Theta_{JC} + T_{CASE})$

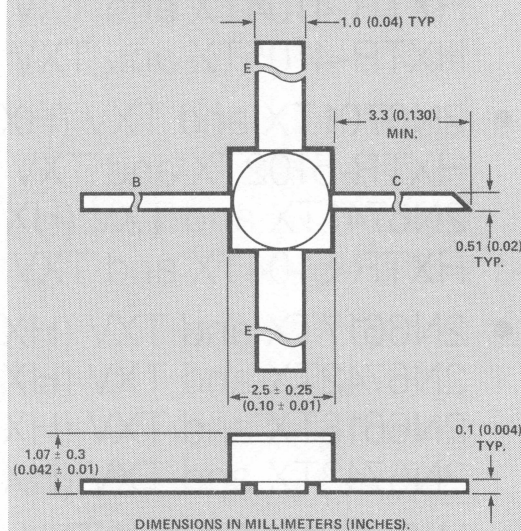
HXTR-2102TX and TXV, HXTR-6106TX and TXV



DIMENSIONS IN MILLIMETERS AND (INCHES).

Outline HPAC-70GT

2N6679TX and TXV,
HXTR-2101TX and TXV, HXTR-6105TX and TXV



DIMENSIONS IN MILLIMETERS (INCHES).

Outline HPAC-100

*Generic 2N6679 (HXTR-2101), HXTR-6105, HXTR-2102 and HXTR-6106)

TABLE I. ELECTRICAL GUARANTEED SPECIFICATIONS AT T_{CASE} = 25°C

Part Number	Package HPAC-	Minimum Collector-Emitter Breakdown Voltage BV_{CES} (V)	Maximum Collector-Emitter Leakage Current I_{CEO} (nA)	Maximum Collector Base Cutoff Current I_{CBO} (nA)	Forward Current Transfer Ratio h_{FE} Min.	Forward Current Transfer Ratio h_{FE} Max.	Minimum Tuned Gain G_T (dB)	Maximum Noise Figure NF_{MIN} (dB)	Minimum Associated Gain G_A (dB)
HXTR-2101	100	30	500	100	50	220	9.0	—	—
HXTR-2102	70GT	30	500	100	50	220	13.0	—	—
HXTR-6105	100	30	500	100	50	220	—	4.2	8.0
HXTR-6106	70GT	30	500	100	50	220	—	3.8	10.0
Test Conditions		I_C = 100 μA	V_{CE} = 15 V	V_{CB} = 15 V	V_{CE} = 15 V, I_C = 15 mA		V_{CE} = 15 V, I_C = 25 mA f = 4 GHz	V_{CE} = 15 V, I_C = 10 mA, f = 4 GHz	
Test Method		3011*	3041	3036	3076*			3246	

*300 μs wide pulse measurement ≤ 2% duty cycle.

High Reliability Programs

Two basic levels of High-Rel testing are offered.

1. The TX suffix indicates a part that is preconditioned and screened to the program shown in Table III and IV, and is marked with an orange dot.
2. The TXV suffix indicates that an internal visual inspection per MIL-STD-750 Method 2072 is included as part of the preconditioning and is marked with a green dot.

Group B quality conformance inspections are performed on each inspection lot in accordance with Table V. Group C quality conformance inspections are performed periodically at 6 month intervals in accordance with Table VI.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number Prefix	Screening Level
2N6679 (HXTR-2101) HXTR-2102 HXTR-6105 HXTR-6106	Commercial
2N6679TX (HXTR-2101TX) HXTR-2102TX HXTR-6105TX HXTR-6106TX	100% Screen (per Tables III and IV)
2N6679TXV (HXTR-2101TXV) HXTR-2102TXV HXTR-6105TXV HXTR-6106TXV	100% Screen and Internal Visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual	2072	TXV Parts Only
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 200°C
3. Thermal Shock (Temperature Cycling)	1051	Condition C, 20 cycles
4. Constant Acceleration	2006	20,000 G, Y_1 axis
5. Hermiticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. High Temperature Reverse Bias (HTRB)	1039	Condition A, t = 168 hours, T_A = 150°C, V_R = 80% of rated V_{BR}.
7. Interim Electrical Tests	—	Per Table I I_{CBO} and h_{FE}
8. Burn In	1039	Condition B, t = 168 hours, T_A = 25°C, HXTR-2101 & 6105: P_T = 450 mW HXTR-2102 & 6106: P_T = 375 mW
9. Final Electrical Tests (PDA = 10%)	—	Per Table I I_{CBO} and h_{FE}

TABLE IV. GROUP A PROGRAM

Test Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Visual and Mechanical	2071		5
Subgroup 2			
DC Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5
Subgroup 3			
DC Electrical Tests at -55°C and +125°C	—	See Table I for Tests and Conditions	5
Subgroup 4			
Dynamic Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5

TABLE V. GROUP B INSPECTION

	MIL-STD-750		
Test/Inspection	**Method**	**Conditions**	**LTPD**
Subgroup 1			
Solderability	2026	Omit Aging	15
Resistance to Solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Test Conditon C1	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Steady-state Operation Life	1027	t = 340 hours, T_A = 25°C HXTR-2101 & 6105: P_T = 450 mW HXTR-2102 & 6106: P_T = 375 mW	5
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Decap, Internal Visual Design Verification	2075	Visual criteria in accordance with qualified design	1 device/0 failure for each lot
Bond Strength	2037	Test condition A; All internal bond wires for each device shall be pulled separately	15 (c = 1) wires (5 devices)
Subgroup 5			
Thermal Resistance	3151		15
Subgroup 6			
High Temperature Life (Non-operating)	1032	T_A = 200°C, t = 340 hours min.	7
Electrical Measurements	—	See Table IV, Subgroup 2	

TABLE VI. GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD
Subgroup 1			
Physical Dimensions	2066	See Figure 1	15
Subgroup 2			
Thermal Shock (Glass Strain)	1056	Test condition A	10
Terminal Strength	2036	Test condition E Weight = 3 oz., 3 arcs of 90° each	
Hermetic Seal	1071		
Fine Leak		Test condition H	
Gross Leak		Test condition C	
Moisture Resistance	1021	Omit initial conditioning	
External Visual	2071		
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Shock	2016	5 blows each axis, X_1, Y_1, & Z_1; 1500 G, 0.5 m/sec.	10
Vibration Variable Frequency	2056		
Constant Acceleration	2006	20,000 G min., Y_1, Y_2, & X_1	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Salt Atmosphere (Corrosion)	1041		15
Subgroup 5			
Steady-state Operating Life	1026	t = 1000 hours T_A = 25°C HXTR-2101 & 6105: P_T = 450 mW HXTR-2102 & 6106: P_T = 375 mW	λ = 10
Electrical Measurements	—	See Table IV, Subgroup 2	

HEWLETT PACKARD

HIGH RELIABILITY LOW COST GENERAL PURPOSE TRANSISTORS

HXTR-3101TX and TXV*
2N6838TX and TXV
(HXTR-3103TX and TXV)

Features

HIGH GAIN

LOW NOISE FIGURE

HIGH GAIN BANDWIDTH PRODUCT

WIDE DYNAMIC RANGE

LOW COST HERMETIC PACKAGE

Description

These low cost general purpose NPN bipolar transistors are designed for high gain and wide dynamic range. To achieve excellent uniformity and reliability, the design utilizes self-alignment and ion implantation techniques. The common chip is nitride passivated.

These devices are supplied in the HPAC-100X, a rugged metal/ceramic package, capable of meeting the environmental requirements of MIL-S-19500 and the electrical test conditions of MIL-STD-750.

Absolute Maximum Ratings†

(T_{CASE} = 25°C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	70 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200°C
T_{STG}	Storage Temperature	-65°C to +150°C
—	Lead Temperature (Soldering 10 seconds each lead)	+250°C

†Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:

1. A Θ_{JC} maximum of 130°C/W should be used for derating and junction temperature calculations. ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

*Generic HXTR-3101 and 2N6838 (HXTR-3103)

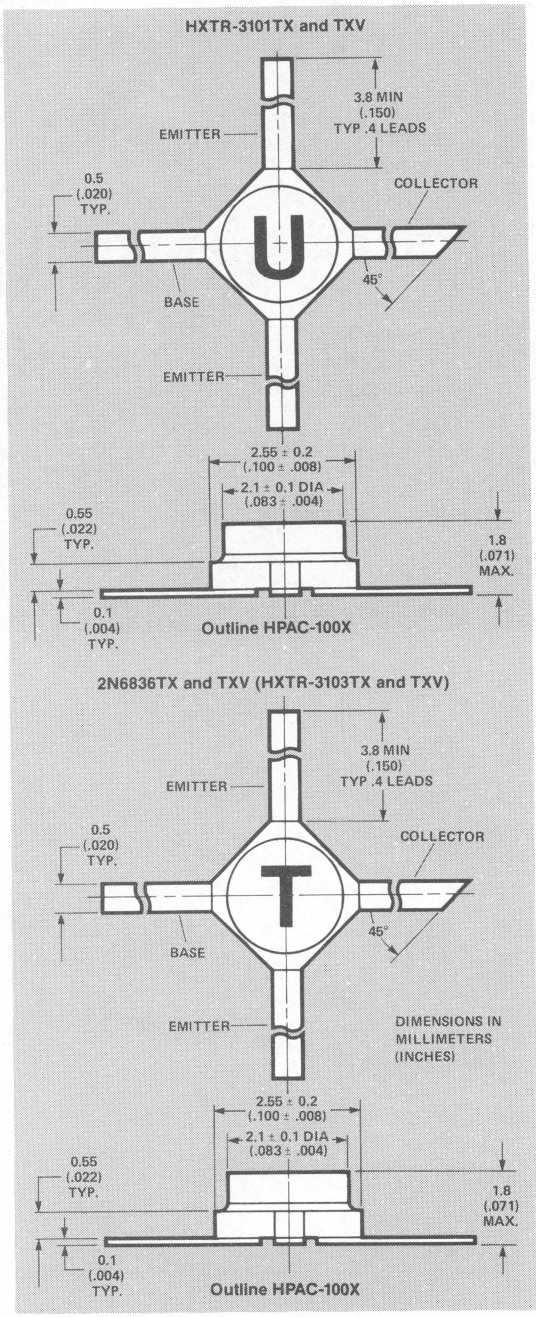


TABLE I. ELECTRICAL GUARANTEED SPECIFICATIONS AT T_{CASE} = 25°C

Part Number	Package HPAC-	Minimum Collector Base Breakdown Voltage BV_{CBO} (V)	Minimum Collector Emitter Breakdown Voltage BV_{CEO} (V)	Maximum Collector Base Cutoff Current I_{CBO} (nA)	Maximum Collector Emitter Cutoff Current I_{CEO} (nA)	Forward Current Transfer Ratio h_{FE}	
						Min.	Max.
HXTR-3101	100X	30	—	500	—	50	180
HXTR-3103	100X	30	16	50	100	50	180
Test Conditions		I_C = 100 mA	I_C = 10 mA	V_{CB} = 15 V	V_{CE} = 15 V	V_C = 10 V, I_C = 10 mA	
MIL-STD-750 Test Method		3001*	3011*	3036	3041	3076*	

Part Number	Minimum Gain Bandwidth Product f_T	Minimum Transducer Gain $\|S_{21E}\|^2$ (dB)	Maximum Noise Figure NF_{MIN} (dB)
HXTR-3103	5.0	13.5	2.3
Test Conditions	V_{CE} = 10 V, I_C = 15 mA	V_{CE} = 10 V, I_C = 15 mA, f = 1000 MHz	V_{CE} = 10 V, I_C = 10 mA, f = 1000 MHz
MIL-STD-750 Test Method			3246

*300 μs wide pulse measurement ≤ 2% duty cycle.

High Reliability Programs

Two basic levels of High-Rel testing are offered.

1. The TX suffix indicates a part that is preconditioned and screened to the program shown in Table III and IV, and is marked with an orange dot.
2. The TXV suffix indicates that an internal visual inspection per MIL-STD-750 Method 2072 is included as part of the preconditioning and is marked with a green dot.

Group B quality conformance inspections are performed on each inspection lot in accordance with Table V. Group C quality conformance inspections are performed periodically at 6 month intervals in accordance with Table VI.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number Prefix	Screening Level
HXTR-3101 2N6838 (HXTR-3103)	Commercial
HXTR-3101TX 2N6838TX (HXTR-3103TX)	100% Screen (per Tables III and IV)
HXTR-3101TXV 2N6838TXV (HXTR-3103TXV)	100% Screen and Internal Visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual	HP Specification A-5956-2028-72	TXV Parts Only[1]
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 150°C
3. Thermal Shock (Temperature Cycling)	1051	Condition C, 20 cycles
4. Constant Acceleration	2006	20,000 G, Y_1 axis
5. Hermiticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. Electrical Tests	—	See Table I I_{CBO} and h_{FE}
7. Burn In	1039	Condition B t = 168 hours, T_A = 25°C, P_T = 300 mW
8. Final Electrical Tests (PDA = 10%)	—	Per Table I I_{CBO} and h_{FE}

Note:
1. High power visual performed on die prior to assembly.

TABLE IV. GROUP A PROGRAM

Test Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Visual and Mechanical	2071		5
Subgroup 2			
DC Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5
Subgroup 3			
DC Electrical Tests at -55°C and +125°C	—	See Table I for Tests and Conditions	5
Subgroup 4			
Dynamic Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5

TABLE V. GROUP B INSPECTION

	MIL-STD-750		
Test/Inspection	Method	Conditions	LTPD
Subgroup 1			
Solderability	2026	Omit Aging	15
Resistance to Solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Test Conditon C1	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Steady-state Operation Life	1027	t = 340 hours, T_A = 25°C, P_T = 300 mW	5
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Decap, Internal Visual Design Verification	2075	Visual criteria in accordance with qualified design	1 device/0 failure for each lot
Bond Strength	2037	Test condition A; All internal bond wires for each device shall be pulled separately	15 (c = 1) wires (5 devices)
Subgroup 5			
Thermal Resistance	3151		15
Subgroup 6			
High Temperature Life (Non-operating)	1032	T_A = 200°C, t = 340 hours min.	7
Electrical Measurements	—	See Table IV, Subgroup 2	

TABLE VI. GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD
Subgroup 1			
Physical Dimensions	2066	See Figure 1	15
Subgroup 2			
Thermal Shock (Glass Strain)	1056	Test condition A	10
Terminal Strength	2036	Test condition E Weight = 3 oz., 3 arcs of 90° each	
Hermetic Seal	1071		
Fine Leak		Test condition H	
Gross Leak		Test condition C	
Moisture Resistance	1021	Omit initial conditioning	
External Visual	2071		
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Shock	2016	5 blows each axis, X_1, Y_1, & Z_1; 1500 G, 0.5 m/sec.	10
Vibration Variable Frequency	2056		
Constant Acceleration	2006	20,000 G min., Y_1, Y_2, & X_1	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Salt Atmosphere (Corrosion)	1041		15
Subgroup 5			
Steady-state Operating Life	1026	t = 1000 hours T_A = 25°C HXTR-2101 & 6105: P_T = 450 mW HXTR-2102 & 6106: P_T = 375 mW	λ = 10
Electrical Measurements	—	See Table IV, Subgroup 2	

HEWLETT PACKARD

HIGH RELIABILITY LOW COST LINEAR POWER TRANSISTORS

HXTR-3102TX and TXV*
2N6839TX and TXV
(HXTR-3104TX and TXV)

Features

HIGH OUTPUT POWER

HIGH P_{1dB} GAIN

HIGH GAIN BANDWIDTH PRODUCT

WIDE DYNAMIC RANGE

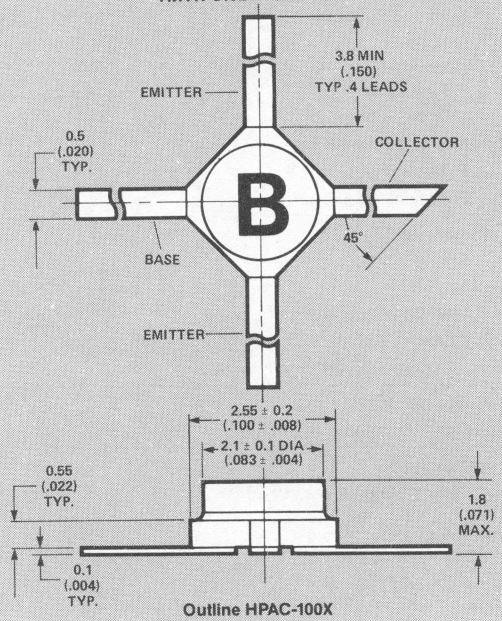
LOW COST HERMETIC PACKAGE

Description

These low cost linear power NPN bipolar transistors are designed for high gain and gain up to 4 GHz. Ion implantation and self-alignment techniques are used in its manufacture to produce excellent uniformity and reliability. The common chip has a dielectric scratch protection over its active area and a Ta_2N ballast resistor for ruggedness.

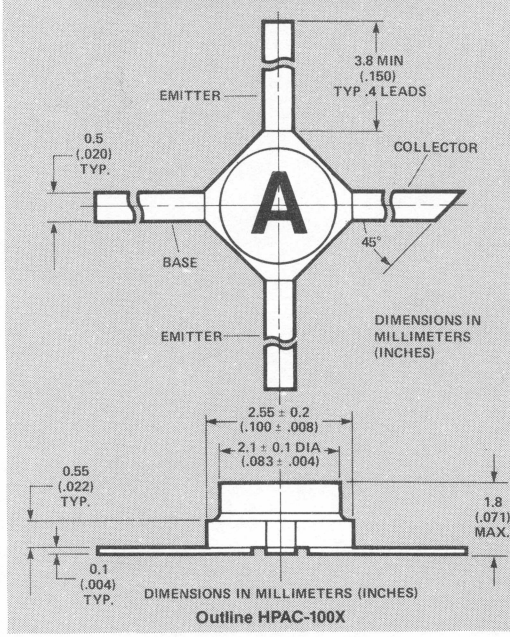
These transistors are supplied in the HPAC-100X, a rugged ceramic package, and are capable of meeting the environmental requirement of MIL-S-19500 and test requirements of MIL-STD-750.

HXTR-3102TX and TXV



Outline HPAC-100X

2N6839TX and TXV (HXTR-3104TX and TXV)



Outline HPAC-100X

Absolute Maximum Ratings†

(T_{CASE} = 25°C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	35 V
V_{CEO}	Collector to Emitter Voltage	25 V
V_{EBO}	Emitter to Base Voltage	3.5 V
I_C	DC Collector Current	100 mA
P_T	Total Device Dissipation	700 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65°C to +150°C
—	Lead Temperature (Soldering 10 seconds each lead)	+250°C

†Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:

1. A Θ_{JC} maximum of 130°C/W should be used for derating and junction temperature calculations. ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

*Generic HXTR-3102 and 2N6839 (HXTR-3104)

TABLE I. ELECTRICAL GUARANTEED SPECIFICATIONS AT T_{CASE} = 25°C

Part Number	Package HPAC-	Minimum Collector Base Breakdown Voltage BV_{CBO} (V)	Minimum Collector Emitter Breakdown Voltage BV_{CEO} (V)	Minimum Emitter Base Breakdown Voltage BV_{EBO} (V)	Maximum Collector Base Cutoff Current I_{CBO} (nA)	Maximum Collector Emitter Leakage Current I_{CEO} (nA)	Forward Current Transfer Ratio h_{FE}	
							Min.	Max.
HXTR-3102	100X	35	—	—	200	—	15	75
HXTR-3104	100X	35	24	3.3	50	75	15	75
Test Conditions		I_C = 100 μA	I_C = 15 mA	I_B = 30 μA	V_{CB} = 20 V	V_{CE} = 15 V	V_{CE} = 15 V, I_C = 10 mA	
MIL-STD-750 Test Method		3001*	3011*	3026*	3036	3041	3076*	

Part Number	Minimum Gain Bandwidth Product f_T	Minimum Transducer Gain $\|S_{21E}\|^2$ (dB)	Minimum Power Output at 1 dB Compression P_{1dB} (dBm)	Minimum Associated 1 dB Compression Gain G_{1dB} (dB)
HXTR-3104	4.0	10.5	19.0	14.0
Test Conditions	V_{CE} = 15 V, I_C = 30 mA	V_{CE} = 15 V, I_C = 30 mA, f = 1000 MHz	V_{CE} = 15 V, I_C = 30 mA, f = 1000 MHz	

*300 μs wide pulse measurement ≤ 2% duty cycle.

High Reliability Programs

Two basic levels of High-Rel testing are offered.

1. The TX suffix indicates a part that is preconditioned and screened to the program shown in Table III and IV, and is marked with an orange dot.
2. The TXV suffix indicates that an internal visual inspection per MIL-STD-750 Method 2072 is included as part of the preconditioning and is marked with a green dot.

Group B quality conformance inspections are performed on each inspection lot in accordance with Table V. Group C quality conformance inspections are performed periodically at 6 month intervals in accordance with Table VI.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number Prefix	Screening Level
HXTR-3102 2N6839 (HXTR-3104)	Commercial
HXTR-3102TX 2N6839TX (HXTR-3104TX)	100% Screen (per Tables III and IV)
HXTR-3102TXV 2N6839TXV (HXTR-3104TXV)	100% Screen and Internal Visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual	HP Specification A-5956-2028-72	TXV Parts Only[1]
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 150°C
3. Thermal Shock (Temperature Cycling)	1051	Condition C, 20 cycles
4. Constant Acceleration	2006	Y_1 axis, 20,000 G
5. Hermiticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. Electrical Tests	—	See Table I I_{CBO} and h_{FE}
7. Burn In	1039	Condition B t = 168 hours, T_A = 25°C, P_T = 400 mW
8. Final Electrical Tests (PDA = 10%)	—	Per Table I I_{CBO} and h_{FE}

Note:
1. High power visual performed on die prior to assembly.

TABLE IV. GROUP A PROGRAM

Test Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5
Subgroup 3 DC Electrical Tests at -55°C and +125°C	—	See Table I for Tests and Conditions	5
Subgroup 4 Dynamic Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5

TABLE V. GROUP B INSPECTION

Test/Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD
Subgroup 1			
Solderability	2026	Omit Aging	15
Resistance to Solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Test Conditon C1	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Steady-state Operation Life	1027	t = 340 hours, T_A = 25°C, P_T = 400 mW	5
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Decap, Internal Visual Design Verification	2075	Visual criteria in accordance with qualified design	1 device/0 failure for each lot
Bond Strength	2037	Test condition A; All internal bond wires for each device shall be pulled separately	15 (c = 1) wires (5 devices)
Subgroup 5			
Thermal Resistance	3151		15
Subgroup 6			
High Temperature Life (Non-operating)	1032	T_A = 200°C, t = 340 hours min.	7
Electrical Measurements	—	See Table IV, Subgroup 2	

TABLE VI. GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD
Subgroup 1			
Physical Dimensions	2066	See Figure 1	15
Subgroup 2			
Thermal Shock (Glass Strain)	1056	Test condition A	10
Terminal Strength	2036	Test condition E Weight = 3 oz., 3 arcs of 90° each	
Hermetic Seal	1071		
Fine Leak		Test condition H	
Gross Leak		Test condition C	
Moisture Resistance	1021	Omit initial conditioning	
External Visual	2071		
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Shock	2016	5 blows each axis, X_1, Y_1, & Z_1; 1500 G, 0.5 m/sec.	10
Vibration Variable Frequency	2056		
Constant Acceleration	2006	20,000 G min., Y_1, Y_2, & X_1	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Salt Atmosphere (Corrosion)	1041		15
Subgroup 5			
Steady-state Operating Life	1026	t = 1000 hours, T_A = 25°C, P_T = 400 mW	λ = 10
Electrical Measurements	—	See Table IV, Subgroup 2	

HEWLETT PACKARD

HIGH RELIABILITY LOW COST HIGH PERFORMANCE TRANSISTORS

HXTR-3615TX and TXV*
HXTR-3645TX and TXV
HXTR-3675TX and TXV

Features

LOW NOISE FIGURE

HIGH ASSOCIATED GAIN

HIGH OUTPUT POWER

HIGH P_{1dB} GAIN

HIGH GAIN BANDWIDTH PRODUCT

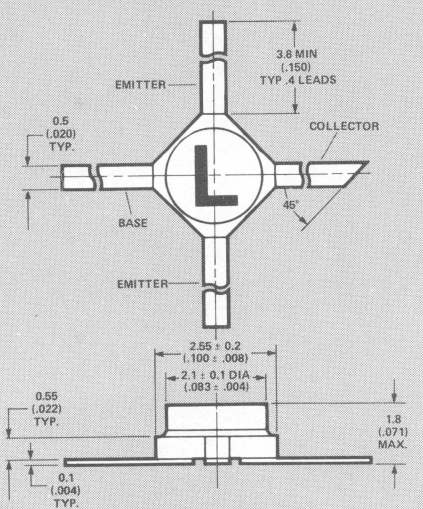
LOW COST HERMETIC PACKAGE

Description/Applications

These NPN silicon bipolar transistors are designed for use in low noise wide band amplifier or medium power oscillation applications requiring superior VHF, UHF, or microwave performance. Excellent device uniformities, performance, and reliability are produced by the ion implantation and self-alignment techniques used in the fabrication of these devices. The common chip is nitride passivated.

These devices are supplied in the HPAC-100X, a rugged hermetic metal-ceramic package capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750.

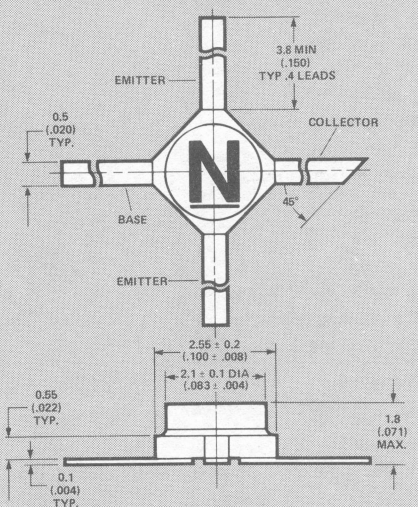
HXTR-3615TX and TXV



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-100X

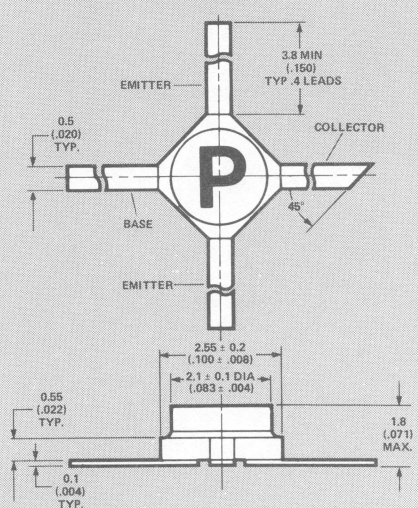
HXTR-3645TX and TXV



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-100X

HXTR-3675TX and TXV



DIMENSIONS IN MILLIMETERS (INCHES)

Outline HPAC-100X

*Generic HXTR-3615, HXTR-3645 and HXTR-3675

Absolute Maximum Ratings†

(T_{CASE} = 25°C)

Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65°C to +150°C
—	Lead Temperature (Soldering 10 seconds each lead)	250°C

Note:

1. A Θ_{JC} maximum of 120°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

TABLE I. ELECTRICAL GUARANTEED SPECIFICATIONS AT T_{CASE} = 25°C

Part Number	Package HPAC-	Minimum Collector Base Breakdown Voltage BV_{CBO} (V)	Minimum Collector Emitter Breakdown Voltage BV_{CEO} (V)	Maximum Collector Base Cutoff Current I_{CBO} (nA)	Maximum Collector Emitter Leakage Current I_{CEO} (nA)	Forward Current Transfer Ratio h_{FE} Min.	Forward Current Transfer Ratio h_{FE} Max.	Maximum Noise Figure NF_{MIN} (dB)	Minimum Associated Gain G_A (dB)
HXTR-3615	100X	25	16	100	100	50	180	—	—
HXTR-3645	100X	30	18	50	50	55	75	2.3[1]	12.2[1]
HXTR-3675	100X	30	18	50	50	55	75	3.4[2]	7.7[2]
Test Conditions		I_C = 100 μA	I_C = 15 mA	V_{CB} = 15 V	V_{CE} = 15 V	V_{CE} = 10 V, I_C = 10 mA		[1] HXTR-3645: V_{CE} = 10 V, I_C = 10 mA, f = 2000 MHz [2] HXTR-3675: V_{CE} = 10 V, I_C = 10 mA, f = 4000 MHz	
MIL-STD-750 Test Method		3001*	3011*	3036	3041	3076*		3246	

*300 μs wide pulse measurement ≤ 2% duty cycle.

High Reliability Programs

Two basic levels of High-Rel testing are offered.

1. The TX suffix indicates a part that is preconditioned and screened to the program shown in Table III and IV, and is marked with an orange dot.
2. The TXV suffix indicates that an internal visual inspection per MIL-STD-750 Method 2072 is included as part of the preconditioning and is marked with a green dot.

Group B quality conformance inspections are performed on each inspection lot in accordance with Table V. Group C quality conformance inspections are performed periodically at 6 month intervals in accordance with Table VI.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number Prefix	Screening Level
HXTR-3615 HXTR-3645 HXTR-3675	Commercial
HXTR-3615TX HXTR-3645TX HXTR-3675TX	100% Screen (per Tables III and IV)
HXTR-3615TXV HXTR-3645TXV HXTR-3675TXV	100% Screen and Internal Visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual	HP Specification A-5956-2028-72	TXV Parts Only[1]
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 200°C
3. Thermal Shock (Temperature Cycling)	1051	Condition C, 20 cycles
4. Constant Acceleration	2006	20,000 G, Y_1 axis
5. Hermiticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. Electrical Tests	—	See Table I I_{CBO} and h_{FE}
7. Burn In	1039	Condition B t = 168 hours, T_A = 25°C, P_T = 350 mW
8. Final Electrical Tests (PDA = 10%)	—	Per Table I I_{CBO} and h_{FE}

Note:
1. High power visual performed on die prior to assembly.

TABLE IV. GROUP A PROGRAM

Test Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5
Subgroup 3 DC Electrical Tests at -55°C and +125°C	—	See Table I for Tests and Conditions	5
Subgroup 4 Dynamic Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5

TABLE V. GROUP B INSPECTION

Test/Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD
Subgroup 1			
Solderability	2026	Omit Aging	15
Resistance to Solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Test Conditon C1	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Steady-state Operation Life	1027	t = 340 hours, T_A = 25°C, P_T = 350 mW	5
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Decap, Internal Visual Design Verification	2075	Visual criteria in accordance with qualified design	1 device/0 failure for each lot
Bond Strength	2037	Test condition A; All internal bond wires for each device shall be pulled separately	15 (c = 1) wires (5 devices)
Subgroup 5			
Thermal Resistance	3151		15
Subgroup 6			
High Temperature Life (Non-operating)	1032	T_A = 200°C, t = 340 hours min.	7
Electrical Measurements	—	See Table IV, Subgroup 2	

TABLE VI. GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD
Subgroup 1			
Physical Dimensions	2066	See Figure 1	15
Subgroup 2			
Thermal Shock (Glass Strain)	1056	Test condition A	10
Terminal Strength	2036	Test condition E Weight = 3 oz., 3 arcs of 90° each	
Hermetic Seal	1071		
Fine Leak		Test condition H	
Gross Leak		Test condition C	
Moisture Resistance	1021	Omit initial conditioning	
External Visual	2071		
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Shock	2016	5 blows each axis, X_1, Y_1, & Z_1; 1500 G, 0.5 m/sec.	10
Vibration Variable Frequency	2056		
Constant Acceleration	2006	20,000 G min., Y_1, Y_2, & X_1	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Salt Atmosphere (Corrosion)	1041		15
Subgroup 5			
Steady-state Operating Life	1026	t = 1000 hours, T_A = 25°C, P_T = 350 mW	λ = 10
Electrical Measurements	—	See Table IV, Subgroup 2	

HEWLETT PACKARD

HIGH RELIABILITY OSCILLATOR TRANSISTORS

HXTR-4101TX and TXV*
HXTR-4103TX and TXV
HXTR-4104TX and TXV
HXTR-4105TX and TXV

Features

HXTR-4101TX and TXV

- GUARANTEED OUTPUT POWER
- HIGH FREQUENCY PERFORMANCE
- USABLE TO 10 GHz PRODUCT
- HERMETIC PACKAGE
- COMMON BASE CONFIGURATION

HXTR-4103TX and TXV

- HIGH OUTPUT POWER
- HIGH GAIN BANDWIDTH PRODUCT
- COMMON COLLECTOR CONFIGURATION
- Ta_2N EMITTER BALLAST RESISTORS

HXTR-4104TX and TXV

- HIGH OUTPUT POWER
- HIGH GAIN BANDWIDTH PRODUCT
- COMMON COLLECTOR CONFIGURATION
- LOW COST HERMETIC PACKAGE
- Ta_2N EMITTER BALLAST RESISTORS

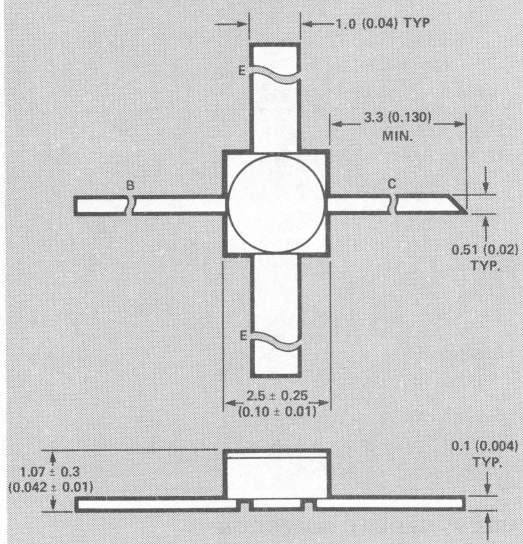
HXTR-4105TX and TXV

- HIGH OUTPUT POWER
- HIGH GAIN BANDWIDTH PRODUCT
- COMMON COLLECTOR CONFIGURATION
- LOW COST HERMETIC PACKAGE

Description

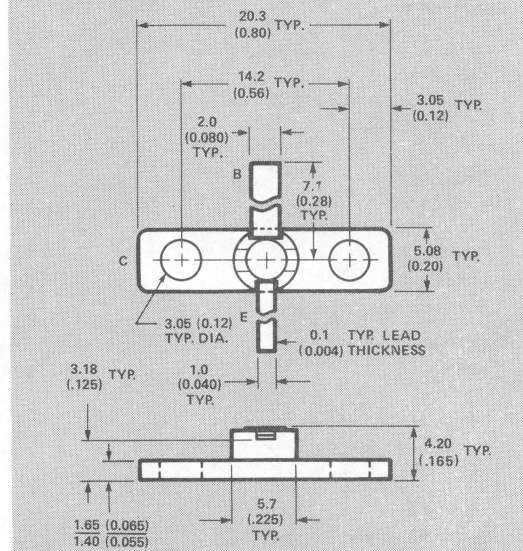
The oscillator transistors are NPN bipolar transistors designed for consistent high oscillator output. The devices utilize ion implantation and self-alignment techniques in their manufacture. The chips are provided with dielectric scratch protection over their active areas.

HXTR-4101TX and TXV



Outline HPAC-100

HXTR-4103TX and TXV

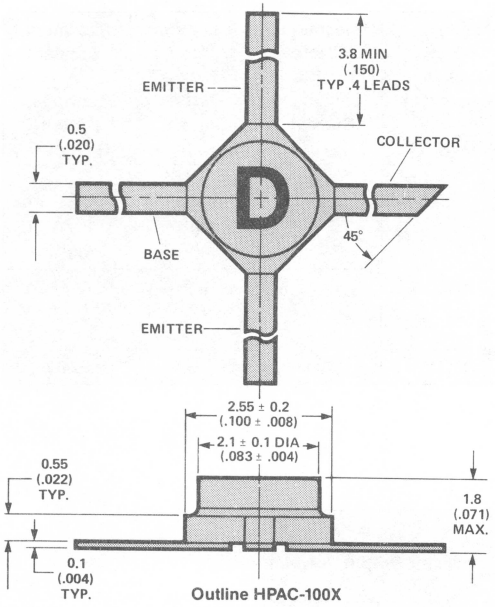


DIMENSIONS IN MILLIMETERS (INCHES).

Outline HPAC-200 GB/GT

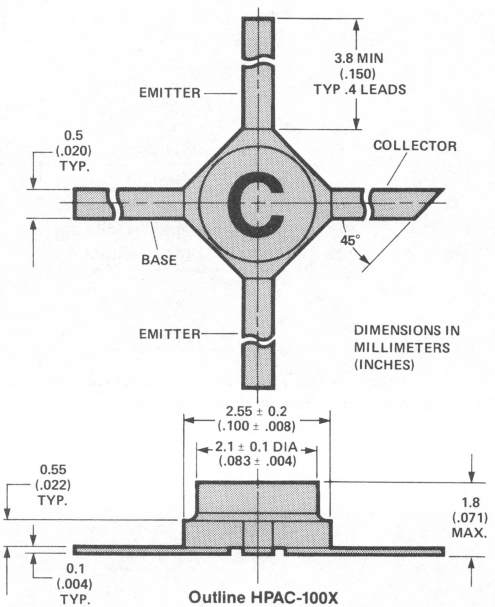
*Generic HXTR-4101, HXTR-4103, HXTR-4104 and HXTR-4105

HXTR-4104TX and TXV



Outline HPAC-100X

HXTR-4105TX and TXV



Outline HPAC-100X

Packaging

Part Number	Package
HXTR-4101TX and TXV	HPAC-100 Metal/Ceramic Hermetic
HXTR-4103TX and TXV	HPAC-200GB/GT Metal/Ceramic Hermetic

Part Number	Package
HXTR-4104TX and TXV, HXTR-4105TX and TXV	HPAC-100X Metal/Ceramic Hermetic Low Cost

These packages are capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750.

Absolute Maximum Ratings*

TABLE I. LIMITS

Part Number	Collector to Base Voltage V_{CBO} (V)	Collector to Emitter Voltage V_{CEO} (V)	Emitter to Base Voltage V_{EBO} (V)	DC Collector Current I_C (mA)	Total Device Dissipation P_T (W)	Junction Temperature T_J (°C)	Storage Temperature T_{STG} (°C)
HXTR-4101	30	20	1.5	70	0.9	200	-65 to +200
HXTR-4103	45	27	4.0	250	4.0	200	-65 to +200
HXTR-4104	40	25	3.5	100	0.7	200	-65 to +150
HXTR-4105	30	18	1.5	65	0.6	200	-65 to +150

*Operation in excess of any of these conditions may result in permanent damage to the device.

Note:

1. Θ_{JC} per Table II should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

TABLE II. THERMAL CHARACTERISTICS

Part Number	Thermal Resistance Θ_{JC} (°C/W)
HXTR-4101	125
HXTR-4103	35
HXTR-4104	140
HXTR-4105	120

TABLE III. ELECTRICAL GUARANTEED SPECIFICATIONS AT T_{CASE} = 25°C

Part Number	Package HPAC-	Configuration	Minimum Collector Base Breakdown Voltage BV_{CBO} (V)	Minimum Collector Emitter Breakdown Voltage BV_{CEO} (V)	Maximum Collector Emitter Leakage Current I_{CEO} (nA)	Maximum Collector Base Cutoff Current I_{CBO} (nA)	Maximum Emitter Base Leakage Current I_{EBO} (nA)
HXTR-4101	100	Common Base	—	30	500	100[1]	—
HXTR-4103	200GB/GT	Common Collector	40[1]	—	—	100[2]	5[1]
HXTR-4104	100X	Common Collector	40[2]	—	—	200[1]	2[1]
HXTR-4105	100X	Common Collector	30[3]	—	—	100[1]	10[2]
Test Conditions			[1]I_C = 10 mA [2]I_C = 3 mA [3]I_C = 0.1 mA	I_C = 100 A	V_{CE} = 15 V	[1]V_{CB} = 15 V [2]V_{CB} = 20 V	[1]V_{EB} = 2 V [2]V_{EB} = 1 V
MIL-STD-750 Test Method			3001*	3011*	3041	3036	3061

*300 μs wide pulse measurement ≤ 2% duty cycle.

Part Number	Forward Current Transfer Ratio h_{FE} Min.	Forward Current Transfer Ratio h_{FE} Max.	Minimum Oscillator Output Power P_{OSC} (dBm)
HXTR-4101	50[1]	220[1]	19.0
HXTR-4103	15[2]	75[2]	—
HXTR-4104	15[3]	75[3]	—
HXTR-4105	55[4]	175[4]	—
Test Conditions	[1]VCE = 15 V, I_C = 15 mA [2]V_{CE} = 18 V, I_C = 110 mA [3]V_{CE} = 15 V, I_C = 30 mA [4]V_{CE} = 10 V, I_C = 10 mA		V_{CB} = 15 V, I_C = 30 mA, f = 4.3 GHz
MIL-STD-750 Test Method	3076*		

*300 μs wide pulse measurement ≤ 20% duty cycle.

High Reliability Programs

Two basic levels of High-Rel testing are offered.

1. The TX suffix indicates a part that is preconditioned and screened to the program shown in Table V and VI, and is marked with an orange dot.
2. The TXV suffix indicates that an internal visual inspection per MIL-STD-750 Method 2072 is included as part of the preconditioning and is marked with a green dot.

Group B quality conformance inspections are performed on each inspection lot in accordance with Table VII. Group C quality conformance inspections are performed periodically at 6 month intervals in accordance with Table VIII.

TABLE IV. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number Prefix	Screening Level
HXTR-4101 HXTR-4103 HXTR-4104 HXTR-4105	Commercial
HXTR-4101TX HXTR-4103TX HXTR-4104TX HXTR-4105TX	100% Screen (per Tables V and VI)
HXTR-4101TXV HXTR-4103TXV HXTR-4104TXV HXTR-4105TXV	100% Screen and Internal Visual

TABLE V. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual		TXV Parts Only[1]
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 200°C
3. Thermal Shock (Temperature Cycling)	1051	Condition C, 20 cycles
4. Constant Acceleration	2006	20,000 G, Y_1 axis
5. Hermiticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. High Temperature Reverse Bias (HTRB)[2]	1039	Condition A, t = 168 hours, T_A = 150°C, V_R = 80% of rated V_{BR}
7. Interim Electrical Tests	—	Per Table I I_{CBO} and h_{FE}
8. Burn In	1039	Condition B, t = 168 hours, T_A = 25°C, P_T: HXTR-4101 = 450 mW HXTR-4103 = 2500 mW HXTR-4104 = 400 mW HXTR-4105 = 350 mW
9. Final Electrical Tests (PDA = 10%)	—	Per Table I I_{CBO} and h_{FE}

Notes:
1. HXTR-4104 and HXTR-4105 have high power visual performed on die only prior to assembly, per HP Specification A-5956-2082-72.
2. Not applicable to HXTR-4104 and HXTR-4105.

TABLE VI. GROUP A PROGRAM

Test Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5
Subgroup 3 DC Electrical Tests at -55°C and +125°C	—	See Table I for Tests and Conditions	5
Subgroup 4 Dynamic Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5

TABLE VII. GROUP B INSPECTION

Test/Inspection	MIL-STD-750		LTPD
	Method	Conditions	
Subgroup 1			
Solderability	2026	Omit Aging	15
Resistance to Solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Test Conditon C1	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Steady-state Operation Life	1027	t = 340 hours, T_A = 25°C HXTR-4101: P_T = 450 mW HXTR-4103: P_T = 2500 mW HXTR-4104: P_T = 400 mW HXTR-4105: P_T = 350 mW	5
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Decap, Internal Visual Design Verification	2075	Visual criteria in accordance with qualified design	1 device/0 failure for each lot
Bond Strength	2037	Test condition A; All internal bond wires for each device shall be pulled separately	15 (c = 1) wires (5 devices)
Subgroup 5			
Thermal Resistance	3151		15
Subgroup 6			
High Temperature Life (Non-operating)	1032	T_A = 200°C, t = 340 hours min.	7
Electrical Measurements	—	See Table IV, Subgroup 2	

TABLE VIII. GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD
Subgroup 1			
Physical Dimensions	2066	See Figure 1	15
Subgroup 2			
Thermal Shock (Glass Strain)	1056	Test condition A	10
Terminal Strength	2036	Test condition E Weight = 3 oz., 3 arcs of 90° each	
Hermetic Seal	1071		
Fine Leak		Test condition H	
Gross Leak		Test condition C	
Moisture Resistance	1021	Omit initial conditioning	
External Visual	2071		
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Shock	2016	5 blows each axis, X_1, Y_1, & Z_1; 1500 G, 0.5 m/sec.	10
Vibration Variable Frequency	2056		
Constant Acceleration	2006	20,000 G min., Y_1, Y_2, & X_1	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Salt Atmosphere (Corrosion)	1041		15
Subgroup 5			
Steady-state Operating Life	1026	t = 1000 hours T_A = 25°C HXTR-4101: P_T = 450 mW HXTR-4103: P_T = 2500 mW HXTR-4104: P_T = 400 mW HXTR-4105: P_T = 350 mW	λ = 10
Electrical Measurements	—	See Table IV, Subgroup 2	

HEWLETT PACKARD

HIGH RELIABILITY LINEAR POWER TRANSISTORS

2N6701TX and TXV*
(HXTR-5101TX and TXV)
HXTR-5102TX and TXV
2N6741TX and TXV
(HXTR-5103TX and TXV)
HXTR-5104TX and TXV

Features

HIGH OUTPUT POWER

HIGH P_{1dB} GAIN

LOW DISTORTION

HIGH POWER-ADDED EFFICIENCY

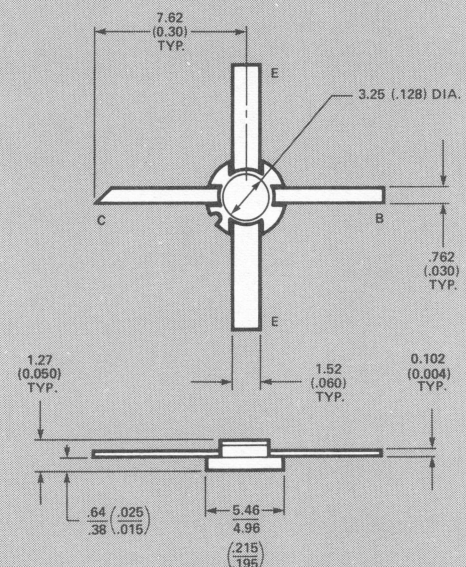
HERMETIC PACKAGES

Description/Applications

These NPN bipolar transistors are designed for high output power and gain up to 5 GHz. To achieve excellent uniformity and reliability, the manufacturing process utilizes ion implantation and self-alignment techniques. The chips have dielectric scratch protection over their active areas and Ta_2N ballast resistors for ruggedness.

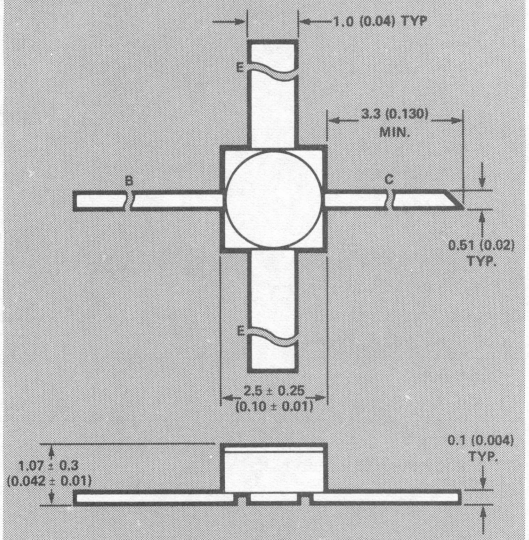
The superior gain power and distortion performance of these transistors commend them for applications in radar, ECM, space and commercial military telecommunications.

2N6741TX and TXV (HXTR-5103TX and TXV), HXTR-5104TX and TXV



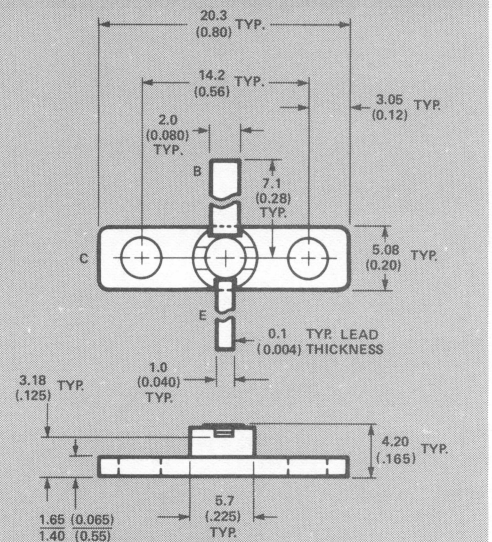
Outline HPAC-200

2N6701TX and TXV (HXTR-5101TX and TXV)



Outline HPAC-100

HXTR-5102TX and TXV



Outline HPAC-200 GB/GT

DIMENSIONS IN MILLIMETERS (INCHES)

*Generic 2N6701 (HXTR-5101), HXTR-5102, 2N6751 (HXTR-5103), and HXTR-5104

Packaging

Part Number	Package	Part Number	Package
2N6701TX and TXV (HXTR-5101TX and TXV)	HPAC-100 Metal/Ceramic Hermetic	2N6741TX and TXV (HXTR-5103TX and TXV) HXTR-5104TX and TXV	HPAC-200 Metal/Ceramic Hermetic
HXTR-5102TX and TXV	HPAC-200GB/GT Metal/Ceramic Hermetic	These packages are capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750.	

Notes:
1. Lead soldering temperature limit is 250°C for soldering 10 sec. for each lead.
2. Θ_{JC} per Table II should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

Absolute Maximum Ratings*

(T_{CASE} = 25°C)

TABLE I.

Part Number	Collector to Base Voltage V_{CBO} (V)	Collector to Emitter Voltage V_{CEO} (V)	Emitter to Base Voltage V_{EBO} (V)	DC Collector Current I_C (mA)	Total Power Dissipation P_T (W)	Junction Temperature T_J (°C)	Storage Temperature T_{STG} (°C)
2N6701 (HXTR-5101)	45	27	4	100	1.1	200	-65 to +200
HXTR-5102	45	27	4	250	4.0	200	-65 to +200
2N6741 (HXTR-5103)	45	27	4	100	1.4	200	-65 to +200
HXTR-5104	45	27	4	250	4.0	200	-65 to +200

*Operation in excess of any of these conditions may result in permanent damage to the device.

TABLE II. THERMAL CHARACTERISTICS

Part Number	Thermal Resistance Θ_{JC} (°C/W)
2N6701 (HXTR-5101)	125
HXTR-5102	35
2N6741 (HXTR-5103)	170
HXTR-5104	40

TABLE III. ELECTRICAL SPECIFICATIONS AT T_{CASE} = 25°C

Part Number	Package HPAC-	Minimum Collector Base Breakdown Voltage BV_{CBO} (V)	Minimum Collector Emitter Breakdown Voltage BV_{CEO} (V)	Minimum Emitter Base Breakdown Voltage BV_{EBO} (V)	Maximum Emitter Base Leakage Current I_{EBO} (μA)	Maximum Collector Emitter Leakage Current I_{CES} (nA)	Maximum Collecter Base Leakage Current I_{CBO} (nA)
2N6701 (HXTR-5101)	100	40[1]	24[1]	3.3[1]	2	200	100
HXTR-5102	200GB/GT	40[2]	24[2]	3.3[2]	5	200	100
2N6741 (HXTR-5103)	200	40[1]	24[1]	3.3[1]	2	200	100
HXTR-5104	200	40[2]	24[2]	3.3[2]	10	200	100
Test Conditions		[1]I_C = 3 mA [2]I_C = 10 mA	[1]I_C = 15 mA [2]I_C = 50 mA	[1]I_B = 30 μA [2]I_B = 100 μA	V_{EB} = 2 V	V_{CE} = 32 V	V_{CB} = 20 V
MIL-STD-750 Test Method		3001*	3011*	3026*	3061	3041	3036

*300 μs wide pulse measurement $\leq$ 2% duty cycle.

TABLE III. ELECTRICAL SPECIFICATION AT T_{CASE} = 25° C (cont.)

Part Number	Forward Current Transfer Ratio h_{FE} Min.	Forward Current Transfer Ratio h_{FE} Max.	Minimum Power Output at 1 dB Compression P_{1dB} (dBm)	Minimum Associated 1 dB Compression Gain G_{1dB} (dBm)
2N6701 (HXTR-5101)	15[1]	75[1]	21.0[1]	6.5[1]
HXTR-5102	15[2]	75[2]	26.5[1]	6.0[1]
2N6741 (HXTR-5103)	15[1]	75[1]	22.0[2]	9.5[2]
HXTR-5104	15[2]	75[2]	28.0[2]	8.0[2]
Test Conditions	V_{CE} = 18 V [1]I_C = 30 mA [2]I_C = 110 mA		[1]f = 2 GHz [2]f = 4 GHz	[1]f = 2 GHz [2]f = 4 GHz
MIL-STD-750 Test Method	3076*			

*300 μs wide pulse measurement at $\leq$ 2% duty cycle.

High Reliability Programs

Two basic levels of High-Rel testing are offered.

1. The TX suffix indicates a part that is preconditioned and screened to the program shown in Table V and VI, and is marked with an orange dot.
2. The TXV suffix indicates that an internal visual inspection per MIL-STD-750 Method 2072 is included as part of the preconditioning and is marked with a green dot.

Group B quality conformance inspections are performed on each inspection lot in accordance with Table VII. Group C quality conformance inspections are performed periodically at 6 month intervals in accordance with Table VIII.

TABLE IV. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number Prefix	Screening Level
2N6701 (HXTR-5101) HXTR-5102 2N6751 (HXTR-5103) HXTR-5104	Commercial
2N6701TX (HXTR-5101TX) HXTR-5102TX 2N6751TX (HXTR-5103TX) HXTR-5104TX	100% Screen (per Tables V and VI)
2N5701TXV (HXTR-5101TXV) HXTR-5102TXV 2N6751TXV (HXTR-5101TXV) HXTR-5104TXV	100% Screen and Internal Visual

TABLE V. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual	2072	TXV Parts Only
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 200°C
3. Thermal Shock (Temperature Cycling)	1051	Condition C, 20 cycles
4. Constant Acceleration	2006	20,000 G, Y_1 axis
5. Hermiticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. High Temperature Reverse Bias (HTRB)	1039	Condition A, t = 168 hours, T_A = 150°C, V_R = 80% of rated V_{BR}
7. Interim Electrical Tests	—	Per Table I I_{CBO} and h_{FE}
8. Burn In	1039	Condition B, t = 168 hours, T_A = 25°C, P_T: HXTR-5101 = 450 mW HXTR-5102 = 2500 mW HXTR-5103 = 700 mW HXTR-5104 = 1130 mW
9. Final Electrical Tests (PDA = 10%)	—	Per Table I I_{CBO} and h_{FE}

TABLE VI. GROUP A PROGRAM

Test Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Visual and Mechanical	2071		5
Subgroup 2			
DC Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5
Subgroup 3			
DC Electrical Tests at -55°C and +125°C	—	See Table I for Tests and Conditions	5
Subgroup 4			
Dynamic Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5

TABLE VII. GROUP B INSPECTION

Test/Inspection	MIL-STD-750 Method	MIL-STD-750 Conditions	LTPD
Subgroup 1			
Solderability	2026	Omit Aging	15
Resistance to Solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Test Conditon C1	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
Electrical Measurements	—	See Table VI, Subgroup 2	
Subgroup 3			
Steady-state Operation Life	1027	t = 340 hours, T_A = 25°C HXTR-5101: P_T = 450 mW HXTR-5102: P_T = 2500 mW HXTR-5103: P_T = 700 mW HXTR-5104: P_T = 1130 mW	5
Electrical Measurements	—	See Table VI, Subgroup 2	
Subgroup 4			
Decap, Internal Visual Design Verification	2075	Visual criteria in accordance with qualified design	1 device/0 failure for each lot
Bond Strength	2037	Test condition A; All internal bond wires for each device shall be pulled separately	15 (c = 1) wires (5 devices)
Subgroup 5			
Thermal Resistance	3151		15
Subgroup 6			
High Temperature Life (Non-operating)	1032	T_A = 200°C, t = 340 hours min.	7
Electrical Measurements	—	See Table VI, Subgroup 2	

TABLE VIII. GROUP C INSPECTION

Test/Inspection	MIL-STD-750		LTPD
	Method	Conditions	
Subgroup 1			
Physical Dimensions	2066	See Figure 1	15
Subgroup 2			
Thermal Shock (Glass Strain)	1056	Test condition A	10
Terminal Strength	2036	Test condition E Weight = 3 oz., 3 arcs of 90° each	
Hermetic Seal	1071		
Fine Leak		Test condition H	
Gross Leak		Test condition C	
Moisture Resistance	1021	Omit initial conditioning	
External Visual	2071		
Electrical Measurements	—	See Table VI, Subgroup 2	
Subgroup 3			
Shock	2016	5 blows each axis, X_1, Y_1, & Z_1: 1500 G, 0.5 m/sec.	10
Vibration Variable Frequency	2056		
Constant Acceleration	2006	20,000 G min., Y_1, Y_2, & X_1	
Electrical Measurements	—	See Table VI, Subgroup 2	
Subgroup 4			
Salt Atmosphere (Corrosion)	1041		15
Subgroup 5			
Steady-state Operating Life	1026	t = 1000 hours T_A = 25°C HXTR-5101: P_T = 450 mW HXTR-5102: P_T = 2500 mW HXTR-5103: P_T = 700 mW HXTR-5104: P_T = 1130 mW	λ = 10
Electrical Measurements	—	See Table VI, Subgroup 2	

HEWLETT PACKARD

HIGH RELIABILITY LOW NOISE TRANSISTORS

2N6617TX and TXV*
(HXTR-6101TX and TXV)
2N6742TX and TXV
(HXTR-6102TX and TXV)
2N6618TX and TXV
(HXTR-6103TX and TXV)
2N6743TX and TXV
(HXTR-6104TX and TXV)

Features

LOW NOISE FIGURE

HIGH ASSOCIATED GAIN

HERMETIC PACKAGES

Description/Applications

These NPN bipolar transistors are designed for minimum noise figure. The devices utilize ion implantation and self-alignment techniques in their manufacture. The common chip is also provided with a dielectric scratch protection over its active area.

The 2N6617TX and TXV (HXTR-6101TX and TXV) and the 2N6742TX and TXV (HXTR-6102TX and TXV) are supplied in the HPAC-70GT, while the 2N6618TX and TXV (HXTR-6103TX and TXV) and the 2N6743TX and TXV (HXTR-6104TX and TXV) are supplied in the HPAC-100. Both packages are rugged metal/ceramic hermetic packages capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750.

Absolute Maximum Ratings†

(T_{CASE} = 25°C)

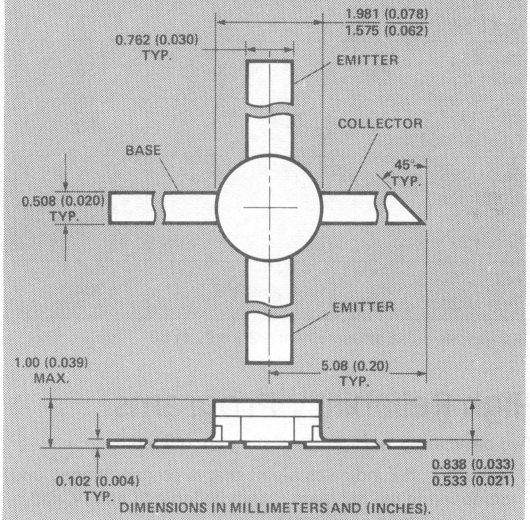
Symbol	Parameter	Limit
V_{CBO}	Collector to Base Voltage	35 V
V_{CEO}	Collector to Emitter Voltage	20 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	20 mA
P_T	Total Device Dissipation	300 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65°C to +200°C
—	Lead Temperature Soldering 10 seconds each lead	+250°C

†Operation in excess of any one of these conditions may result in permanent damage to this device.

Note:

1. For the 2N6617TX and TXV (HXTR-6101TX and TXV) and the 2N6742TX and TXV (HXTR-6102TX and TXV) a Θ_{JC} = 160°C/W maximum should be used for derating and junction temperature calculations. For the 2N6618TX and TXV (HXTR-6103TX and TXV) and the 2N6743TX and TXV (HXTR-6104TX and TXV) a Θ_{JC} = 150°C/W maximum should be used for calculating junction temperature from $T_J = P_D \times \Theta_{JC} + T_{CASE}$.

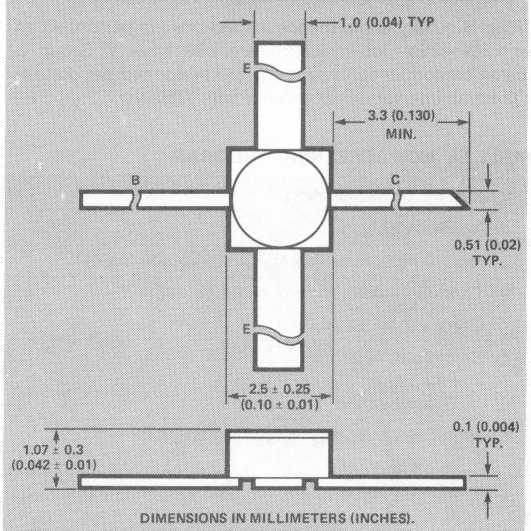
2N6617TX and TXV (HXTR-6101TX and TXV), 2N6742TX and TXV (HXTR-6102TX and TXV)



DIMENSIONS IN MILLIMETERS AND (INCHES).

Outline HPAC-70GT

2N6618TX and TXV (HXTR-6103TX and TXV), 2N6743TX and TXV (HXTR-6104TX and TXV)



DIMENSIONS IN MILLIMETERS (INCHES).

Outline HPAC-100

*Generic 2N6617 (HXTR-6101), 2N6742 (HXTR-6102), 2N6618 (HXTR-6103), and 2N6742 (HXTR-6104)

TABLE I. ELECTRICAL GUARANTEED SPECIFICATIONS AT T_{CASE} = 25°C

Part Number	Packaged HPAC-	Minimum Collector Emitter Breakdown Voltage BV_{CES} (V)	Maximum Collector Emitter Leakage Current I_{CEO} (nA)	Maximum Collector Cutoff Current I_{CBO} (nA)	Forward Current Transfer Ratio h_{FE} Min.	Forward Current Transfer Ratio h_{FE} Max.	Maximum Noise Figure NF_{MIN} (dB)	Minimum Associated Gain G_A (dB)
2N6617 (HXTR-6101)	70GT	30	500	100	50[1]	250[1]	3.0[3]	8.0[3]
2N6742 (HXTR-6102)	70GT	30	500	100	50[1]	250[1]	2.7[3]	8.0[3]
2N6618 (HXTR-6103)	100	30	500	100	50[2]	250[2]	2.2[2]	11.0[2]
2N6743 (HXTR-6104)	100	30	500	100	50[2]	250[2]	1.6[1]	13.0[1]
Test Conditions		I_C = 100 μA	V_{CE} = 10 V	V_{CB} = 10 V	[1]V_{CE} = 10 V, I_C = 4 mA [2]V_{CE} = 10 V, I_C = 3 mA		[1]f = 1.5 GHz [2]f = 2 GHz [3]f = 4 GHz	
MIL-STD-750 Test Method		3001*	3041*	3036	3076*		3246	

*300 μs wide pulse measurement ≤ 2% duty cycle.

High Reliability Programs

Two basic levels of High-Rel testing are offered.

1. The TX suffix indicates a part that is preconditioned and screened to the program shown in Table III and IV, and is marked with an orange dot.
2. The TXV suffix indicates that an internal visual inspection per MIL-STD-750 Method 2072 is included as part of the preconditioning and is marked with a green dot.

Group B quality conformance inspections are performed on each inspection lot in accordance with Table V. Group C quality conformance inspections are performed periodically at 6 month intervals in accordance with Table VI.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number Prefix	Screening Level
2N6617 (HXTR-6101) 2N6742 (HXTR-6102) 2N6618 (HXTR-6103) 2N6743 (HXTR-6104)	Commercial
2N6617TX (HXTR-6101TX) 2N6742TX (HXTR-6102TX) 2N6618TX (HXTR-6103TX) 2N6743TX (HXTR-6104TX)	100% Screen (per Tables III and IV)
2N6617TXV (HXTR-6101TXV) 2N6742TXV (HXTR-6102TXV) 2N6618TXV (HXTR-6103TXV) 2N6743TXV (HXTR-6104TXV)	100% Screen and Internal Visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual	2072	TXV Parts Only
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 200°C
3. Thermal Shock (Temperature Cycling)	1051	Condition C, 20 cycles
4. Constant Acceleration	2006	20,000 G, Y_1 axis
5. Hermiticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. High Temperature Reverse Bias (HTRB)	1039	Condition A, t = 168 hours, T_A = 150°C, V_R = 80% of rated V_{BR}
7. Interim Electrical Tests	—	Per Table I I_{CBO} and h_{FE}
8. Burn In	1039	Condition B, t = 168 hours, T_A = 25°C, P_T = 150 mW
9. Final Electrical Tests (PDA = 10%)	—	Per Table I I_{CBO} and h_{FE}

TABLE IV. GROUP A PROGRAM

Test Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Visual and Mechanical	2071		5
Subgroup 2			
DC Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5
Subgroup 3			
DC Electrical Tests at -55°C and +125°C	—	See Table I for Tests and Conditions	5
Subgroup 4			
Dynamic Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5

TABLE V. GROUP B INSPECTION

Test/Inspection	MIL-STD-750		LTPD
	Method	Conditions	
Subgroup 1			
Solderability	2026	Omit Aging	15
Resistance to Solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Test Conditon C1	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Steady-state Operation Life	1027	t = 340 hours, T_A = 25°C, P_T = 150 mW	5
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Decap, Internal Visual Design Verification	2075	Visual criteria in accordance with qualified design	1 device/0 failure for each lot
Bond Strength	2037	Test condition A; All internal bond wires for each device shall be pulled separately	15 (c = 1) wires (5 devices)
Subgroup 5			
Thermal Resistance	3151		15
Subgroup 6			
High Temperature Life (Non-operating)	1032	T_A = 200°C, t = 340 hours min.	7
Electrical Measurements	—	See Table IV, Subgroup 2	

TABLE VI. GROUP C INSPECTION

Test/Inspection	MIL-STD-750		LTPD
	Method	Conditions	
Subgroup 1			
Physical Dimensions	2066	See Figure 1	15
Subgroup 2			
Thermal Shock (Glass Strain)	1056	Test condition A	10
Terminal Strength	2036	Test condition E Weight = 3 oz., 3 arcs of 90° each	
Hermetic Seal	1071		
Fine Leak		Test condition H	
Gross Leak		Test condition C	
Moisture Resistance	1021	Omit initial conditioning	
External Visual	2071		
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Shock	2016	5 blows each axis, X_1, Y_1, & Z_1; 1500 G, 0.5 m/sec.	10
Vibration Variable Frequency	2056		
Constant Acceleration	2006	20,000 G min., Y_1, Y_2, & X_1	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Salt Atmosphere (Corrosion)	1041		15
Subgroup 5			
Steady-state Operating Life	1026	t = 1000 hours, T_A = 25°C, P_T = 150 mW	λ = 10
Electrical Measurements	—	See Table IV, Subgroup 2	

HEWLETT PACKARD

HIGH RELIABILITY LOW NOISE HIGH PERFORMANCE TRANSISTOR

HXTR-7111TX and TXV*

Features

GUARANTEED NOISE FIGURE
3.4 dB Maximum NF_{MIN} at 4 GHz

GUARANTEED ASSOCIATED GAIN
8.1 dB Minimum G_A at 4 GHz

HIGH OUTPUT POWER
18.5 dBm Typical P_{1dB} at 4 GHz

HIGH P_{1dB} GAIN
9.1 dB Typical G_{1dB} at 4 GHz

HIGH GAIN BANDWIDTH PRODUCT
6.0 GHz Typical f_T

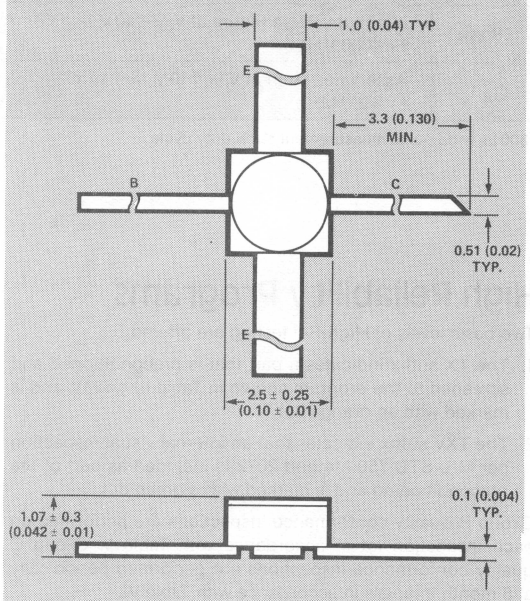
HERMETIC PACKAGE

Description

The HXTR-7111TX and TXV are NPN silicon bipolar transistors designed for use in low noise wide band amplifier or medium power oscillation applications requiring superior VHF, UHF, or microwave performance. Excellent device uniformities, performance, and reliability are produced by the ion implantation and self-alignment techniques used in the fabrication of these devices. The chip is nitride passivated.

The HXTR-7111TX and TXV are supplied in the HPAC-100, a rugged hermetic metal-ceramic package capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750.

HXTR-7111TX and TXV



DIMENSIONS IN MILLIMETERS (INCHES).

Outline HPAC-100

Absolute Maximum Ratings†

(T_{CASE} = 25°C)

Symbol	Parameter	Value
V_{CBO}	Collector to Base Voltage	30 V
V_{CEO}	Collector to Emitter Voltage	18 V
V_{EBO}	Emitter to Base Voltage	1.5 V
I_C	DC Collector Current	65 mA
P_T	Total Device Dissipation	600 mW
T_J	Junction Temperature	200° C
T_{STG}	Storage Temperature	-65°C to +200°C
—	Lead Temperature (Soldering 10 seconds each lead)	+250°C

†Operation in excess of any one of these conditions may result in permanent damage to this device.

Notes:

1. A Θ_{JC} maximum of 120°C/W should be used for derating and junction temperature calculations ($T_J = P_D \times \Theta_{JC} + T_{CASE}$).

*Generic HXTR-7111

TABLE I. ELECTRICAL GUARANTEED SPECIFICATIONS AT T_{CASE} = 25° C

Symbol	Parameters and Test Conditions	MIL-STD-750 Test Method	Units	Min.	Max.
BV_{CBO}	Collector-Base Breakdown Voltage at I_C = 100 μA	3001*	V		30
BV_{CEO}	Collector-Emitter Breakdown Voltage at I_C = 15 mA	3011*	V	18	
I_{CBO}	Collector-Base Cutoff Current at V_{CB} = 15 V	3036	nA		50
I_{CEO}	Collector-Emitter Leakage Current at V_{CE} = 15 V	3041	nA		50
h_{FE}	Forward Current Transfer Ratio at V_{CE} = 10 V, I_C = 10 mA	3076		55	175
NF_{MIN}	Minimum Noise Figure at V_{CE} = 10 V, I_C = 10 mA f = 4000 MHz	3246	dB		3.4
G_A	Associated Gain at V_{CE} = 10 V, I_C = 10 mA f = 4000 MHz	3246	dB	8.1	

*300 μs wide pulse measurement ≤ 2% duty cycle.

High Reliability Programs

Two basic levels of High-Rel testing are offered.

1. The TX suffix indicates a part that is preconditioned and screened to the program shown in Table III and IV, and is marked with an orange dot.
2. The TXV suffix indicates that an internal visual inspection per MIL-STD-750 Method 2072 is included as part of the preconditioning and is marked with a green dot.

Group B quality conformance inspections are performed on each inspection lot in accordance with Table V. Group C quality conformance inspections are performed periodically at 6 month intervals in accordance with Table VI.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number Prefix	Screening Level
HXTR-7111	Commercial
HXTR-7111TX	100% Screen (per Tables III and IV)
HXTR-7111TXV	100% Screen and Internal Visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual	2072	TXV Parts Only
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 200°C
3. Thermal Shock (Temperature Cycling)	1051	Condition C, 20 cycles
4. Constant Acceleration	2006	20,000 G, Y_1 axis
5. Hermiticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. High Temperature Reverse Bias (HTRB)	1039	Condition A, t = 168 hours, T_A = 150°C, V_R = 80% of rated V_{BR}
7. Interim Electrical Tests	—	Per Table I I_{CBO} and h_{FE}
8. Burn In	1039	Condition B, t = 168 hours, T_A = 25°C, P_T = 400 mW
9. Final Electrical Tests (PDA = 10%)	—	Per Table I I_{CBO} and h_{FE}

TABLE IV. GROUP A PROGRAM

Test Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Visual and Mechanical	2071		5
Subgroup 2			
DC Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5
Subgroup 3			
DC Electrical Tests at -55°C and +125°C	—	See Table I for Tests and Conditions	5
Subgroup 4			
Dynamic Electrical Tests at 25°C	—	See Table I for Tests and Conditions	5

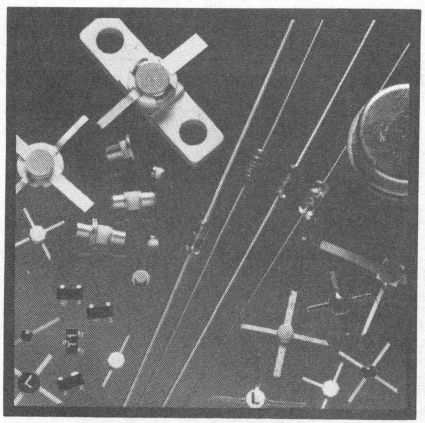
TABLE V. GROUP B INSPECTION

	MIL-STD-750		
Test/Inspection	Method	Conditions	LTPD
Subgroup 1			
Solderability	2026	Omit Aging	15
Resistance to Solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Test Conditon C1	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Steady-state Operation Life	1027	t = 340 hours, T_A = 25°C, P_T = 400 mW	5
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Decap, Internal Visual Design Verification	2075	Visual criteria in accordance with qualified design	1 device/0 failure for each lot
Bond Strength	2037	Test condition A; All internal bond wires for each device shall be pulled separately	15 (c = 1) wires (5 devices)
Subgroup 5			
Thermal Resistance	3151		15
Subgroup 6			
High Temperature Life (Non-operating)	1032	T_A = 200°C, t = 340 hours min.	7
Electrical Measurements	—	See Table IV, Subgroup 2	

TABLE VI. GROUP C INSPECTION

Test/Inspection	MIL-STD-750		LTPD
	Method	Conditions	
Subgroup 1			
Physical Dimensions	2066	See Figure 1	15
Subgroup 2			
Thermal Shock (Glass Strain)	1056	Test condition A	10
Terminal Strength	2036	Test condition E Weight = 3 oz., 3 arcs of 90° each	
Hermetic Seal	1071		
Fine Leak		Test condition H	
Gross Leak		Test condition C	
Moisture Resistance	1021	Omit initial conditioning	
External Visual	2071		
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 3			
Shock	2016	5 blows each axis, X_1, Y_1, & Z_1: 1500 G, 0.5 m/sec.	10
Vibration Variable Frequency	2056		
Constant Acceleration	2006	20,000 G min., Y_1, Y_2, & X_1	
Electrical Measurements	—	See Table IV, Subgroup 2	
Subgroup 4			
Salt Atmosphere (Corrosion)	1041		15
Subgroup 5			
Steady-state Operating Life	1026	t = 1000 hours, T_A = 25°C, P_T = 400 mW	λ = 10
Electrical Measurements	—	See Table IV, Subgroup 2	

Reliability Data for Silicon Bipolar Transistors



HEWLETT PACKARD

RELIABILITY PERFORMANCE BIPOLAR TRANSISTORS

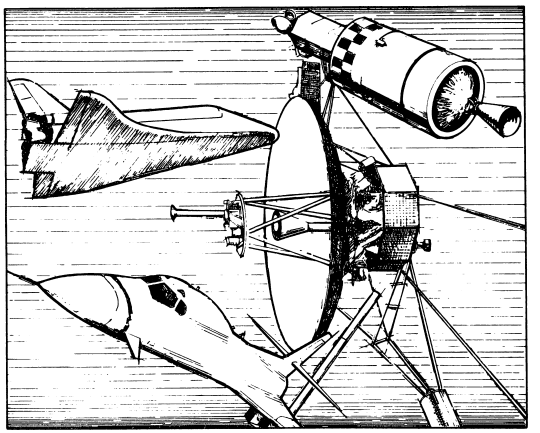
HXTR-2000
HXTR-3000
HXTR-5000
HXTR-6000
HXTR-7000
PRODUCT SERIES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability information for all families of devices.

These bipolar transistor products utilize a common manufacturing process, to include similar metallization systems, ion implantation, and self-alignment techniques, maintaining in this fashion a high degree of uniform quality and reliability.

The reliability performance of this bipolar transistor family is governed primarily by a thermally activated process. Hence, the junction temperature T_j of the device dictates the performance achieved under various applications.

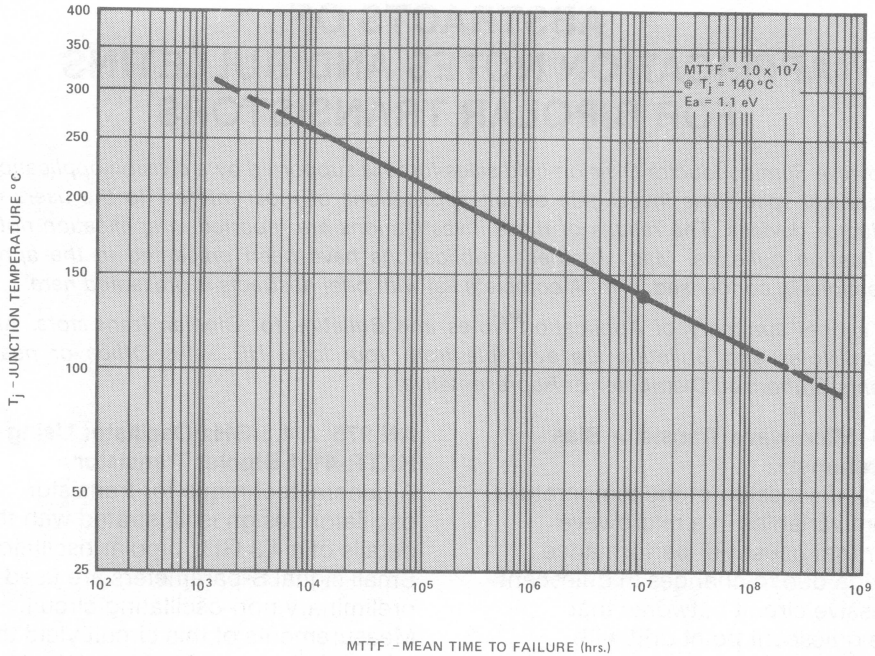


Applications

This information represents the capabilities of the generic device in ceramic hermetic packaging. Performance criteria and Mean Time To Failure (MTTF) values presented here are achieved with MIL-S-19500 level sampling.

Life and Environmental Test Performance

Life/Environment Stress	Test Method	Stress Condition	Minimum Stress Duration	Typical Performance Criteria, LTPD or λ
Operating Life	MIL-STD-750 Method 1026.3	T_J/T_{CH} = 200° C	1000 Hours	3
High Temperature Storage	MIL-STD-883 Method 1008	Test Condition D, T_A = 200° C	1000 Hours	10
HTRB	MIL-STD-750 Method 1038/ 1039	Test Condition A, T_A = 200° C	1000 Hours	3
Temperature Cycling	MIL-STD-883 Method 1010	Test Condition D, -65° C to 200° C	200 Cycles	2
Thermal Shock	MIL-STD-883 Method 1011	Test Condition D, -65° C to 200° C	200 Cycles	2
Solderability	MIL-STD-202 Method 208	T_{PbSn} @ 230° C	5 sec. dwell	10
Hermeticity	MIL-STD-883 Method 1014	KR-85/Dry N_2 Penetrant Dye	N/A	2
Moisture Resistance	MIL-STD-202 Method 106	65° C/98% R.H.	10 days	15
Vibration Variable Frequency	MIL-STD-750 Method 2056	100 to 2,000 Hz	4 Cycles @ Sweep Rate < 4 min.	2
Mechanical Shock	MIL-STD-883 Method 2002	Acceleration @ 1500G's	0.5 msec. Pulse Duration	2
Terminal Strength	MIL-STD-750 Method 2036.3	TBA (Package Related)	30 sec. duration	10



Mean Time to Failure (MTTF) vs. Junction Temperature

Notes:

1. To determine MTTF, calculate $T_j = P_T \times \Theta_{JC} + T_{CASE}$.
2. To determine the maximum bias conditions ($P_T \simeq V_{CE} \times I_C$) to achieve a minimum MTTF, calculate $P_{T\ max} = \frac{T_{J\ max} - T_{CASE}}{\Theta_{JC}}$. Do not exceed the absolute maximum P_T ratings specified for the transistor.

ABSTRACTS OF APPLICATION NOTES AND BULLETINS FOR BIPOLAR TRANSISTORS

The Microwave Semiconductor Division field sales force is supported by a division applications staff. These technical specialists investigate circuit applications of most interest to the users of these semiconductor devices. The results of these investigations are reported in application notes or in brief application bulletins. Many of these publications have been presented in the appropriate catalog sections in condensed form. A complete list with brief abstracts is presented here.

Below is a brief summary of Application Notes and Bulletins for Bipolar Transistors. All of the Application Notes and Bulletins are available from your local HP Sales Office or nearest HP Components Authorized Distributor or Representative.

AN 944-1 Microwave Transistor Bias Considerations
A practical discussion of the temperature dependent variables in a microwave transistor that cause RF performance degradation due to changes in quiescent point. Passive circuit networks that minimize quiescent point drift with temperature are analyzed, and the general equations for dc stability factors are given. Emphasis on practical circuit design is highlighted by typical circuit examples.

AN 967 A Low Noise 4 GHz Amplifier Using the HXTR-6101 Silicon Bipolar Transistor
Describes in detail the design of a single-stage, state-of-the-art, low noise amplifier at 4 GHz using the HXTR-6101 silicon bipolar transistor. Both the input and output matching networks are described.

AN 972 Two Telecommunications Power Amplifiers for 2 and 4 GHz Using the HXTR-5102 Silicon Bipolar Power Transistor
Describes in detail the design of two linear power amplifiers using the HXTR-5102. In each case, small signal S-parameters and power contours are used in the design.

AN 974 Die Attach and Bonding Techniques for Diodes and Transistors
Several package and chip devices are available for use in hybrid circuits. This application note provides detailed instructions for attaching and bonding these devices.

AN 975 A 4.3 GHz Oscillator Using the HXTR-4101 Bipolar Transistor
A general technique for transistor oscillator design is illustrated with the details of a 4.3 GHz bipolar oscillator. Small signal S-parameters are used for a preliminary non-oscillating circuit. Measurements of this circuit yield the information needed to complete the circuit design.

AN 980 A Cost Effective Amplifier Design Approach at 425 MHz Using the HXTR-3101 Silicon Bipolar Transistor
The HXTR-3101, simplified matching networks, and off-the-shelf components are used in an amplifier design which achieves a gain of 13.5 dB at 425 MHz. Construction details include the circuit board layout and component placement.

AN 981 The Design of a 900 MHz Oscillator with the HXTR-3102
This application note describes two useful techniques for determining the optimum load impedance for an oscillator. The device-line technique applies to an initial circuit, with a negative input resistance at the design frequency, that does not oscillate when loaded by a 50 ohm system, and the load-pull technique applies to an initial circuit that is already oscillating. These techniques are used to design a very efficient 900 MHz oscillator.

AN 982 A 900 MHz Driver Amplifier Stage Using the HXTR-3102
A modified version of the "load-pull" technique is used in the design of a power driver amplifier stage at 900 MHz. The final output power is 21.5 dBm at 900 MHz. Design and construction details are provided.

AN 994 A 2 GHz Power Oscillator Using the HXTR-4103 Bipolar Transistor
This application note describe the design of a 1 watt oscillator and including the artwork layout for the printed circuit board.

AN 998 A 75 Ohm 470-806 MHz Low Noise Amplifier Using the HXTR-3121 Bipolar Transistor
This application note describes the design and construction of a two stage 470 MHz to 806 MHz LNA using the 100 mil plastic package HXTR-3121 transistor. The amplifier has a typical gain of 29 dB, a noise figure of less than 3.3 dB and an input and output VSWR less than 2:1 into 75 ohms. A computer program is used to synthesize the input, interstage and output impedance matching networks. Complete construction details are given.

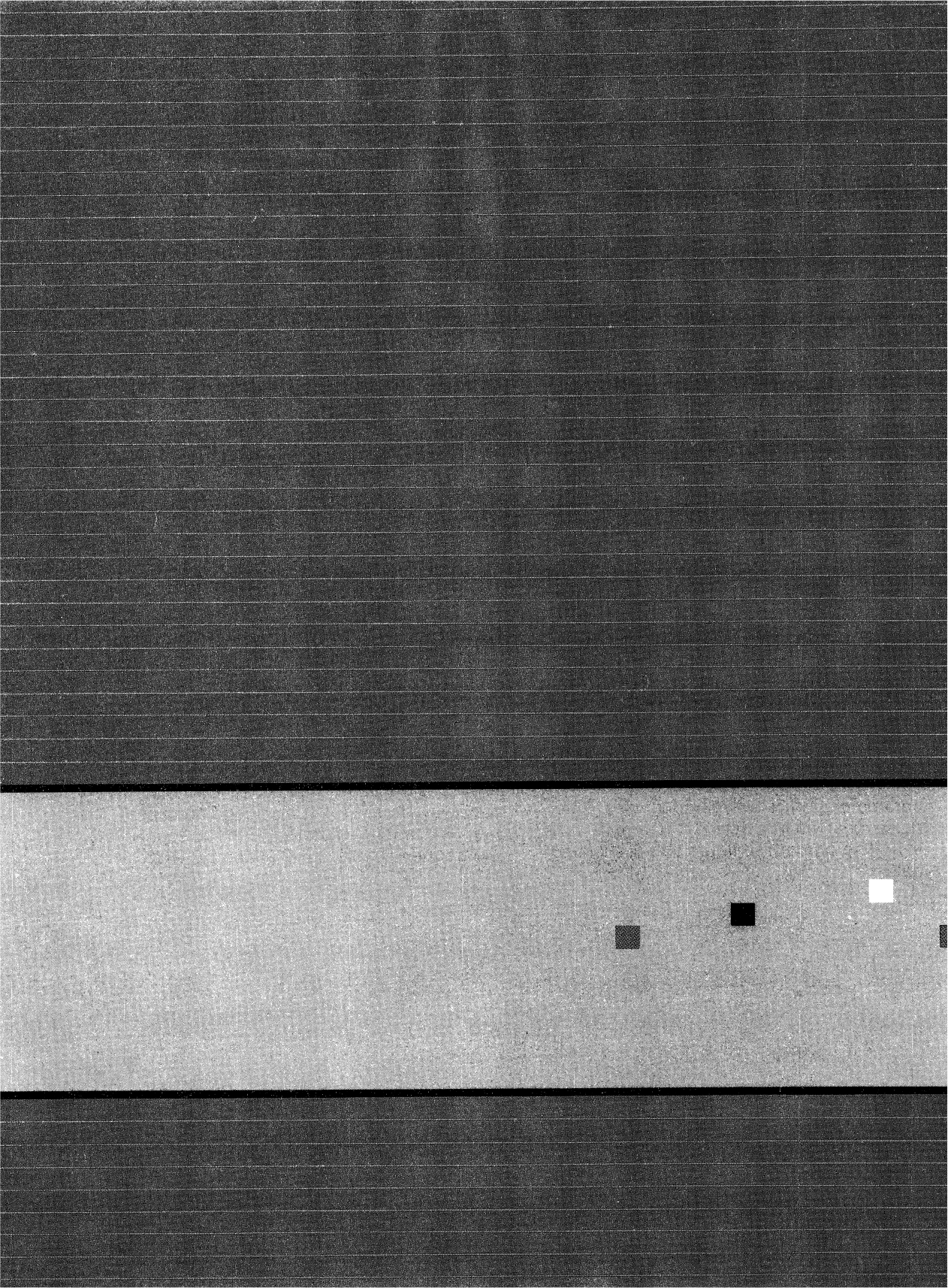
AB 9 Derivation, Definition and Application of Noise Measure
The associated gain at optimum noise figure bias becomes an important parameter at microwave frequencies. The noise measure of a device is a term including both noise figure and associated gain.

AB 10 Transistor Noise Measurements
The increasing acceptance of GaAs field effect and silicon bipolar transistors in low noise pre-amp applications has stressed the importance of the techniques used in measuring noise figure. This application bulletin discusses the various techniques and possible sources of error in making a transistor noise figure measurement.

AB 13 Transistor Speed Up Using Schottky Diodes
Significant reduction in transistor switching delay time can be activated by adding a Schottky diode and a PIN diode to the transistor switching circuit. This improvement in switching performance also extends the oscillator capability of the transistor to higher frequencies.

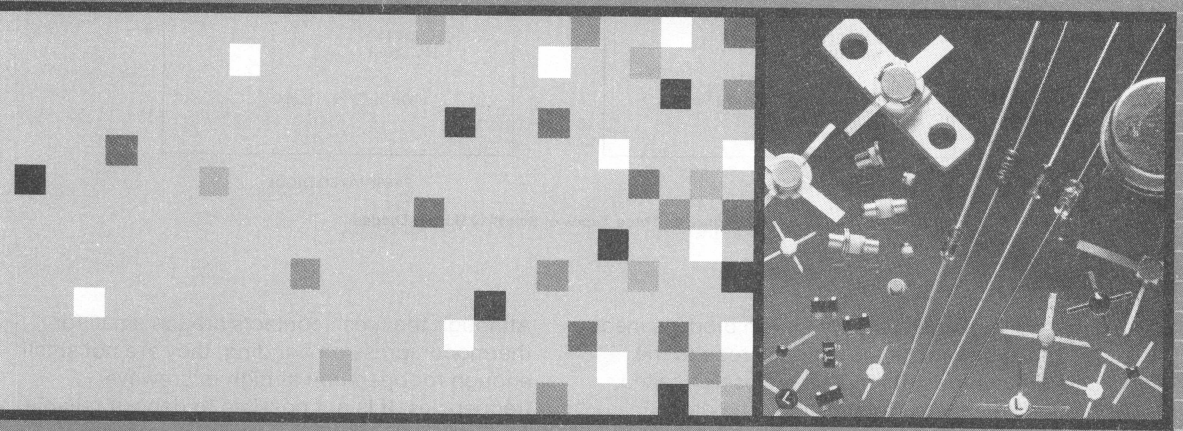
AB 17 Noise Parameters and Noise Circles for the HXTR-6101, -6102, -6103, -6104 and -6105 Low Noise Transistors
Noise figures as a function of source reflection coefficient (Γ_S) can be expressed using three parameters, F_{min}, R_n and Γ_o known as noise parameters. These parameters are presented for five microwave transistors. The method of generating noise circles is given in a step-by-step fashion.

AB 18 The Performance of the HXTR-6101 at Submilliampere Bias Levels
Describes the performance of a low noise microwave transistor at bias conditions of V_{CE} = 3 V and I_C = 1.0 mA, 0.5 mA, 0.25 mA and frequencies 1.0, 1.5, 2.0, and 3.0 GHz.



Schottky Barrier Diodes

- Characteristics 4-2
- Applications 4-4
- Selection Guide 4-6
- Alphanumeric Index 4-10
- Chips 4-15
- Beam Leads 4-18
- Bonding and Handling Procedures for Beam Lead Diodes 4-36
- Packaged Devices 4-37
- High Reliability Data 4-78
- Reliability Data 4-105
- Abstracts of Application Notes and Bulletins .. 4-124



CHARACTERISTICS OF SCHOTTKY BARRIER DIODES

A Schottky barrier diode contains a metal-semiconductor barrier formed by deposition of a metal layer on a semiconductor. The resulting non-linear diode is similar to point contact diodes and p-n junction diodes. The Schottky diode is more rugged than the point contact diode because the contact is not subject to change under vibration. The advantage over the p-n junction is the absence of minority carriers which limit the response speed in switching applications and the high frequency performance in mixing and detecting applications.

Types of Diode Construction

There are several assembly geometries used for Schottky barrier diodes. Three types used in this catalog are shown in Figure 1.

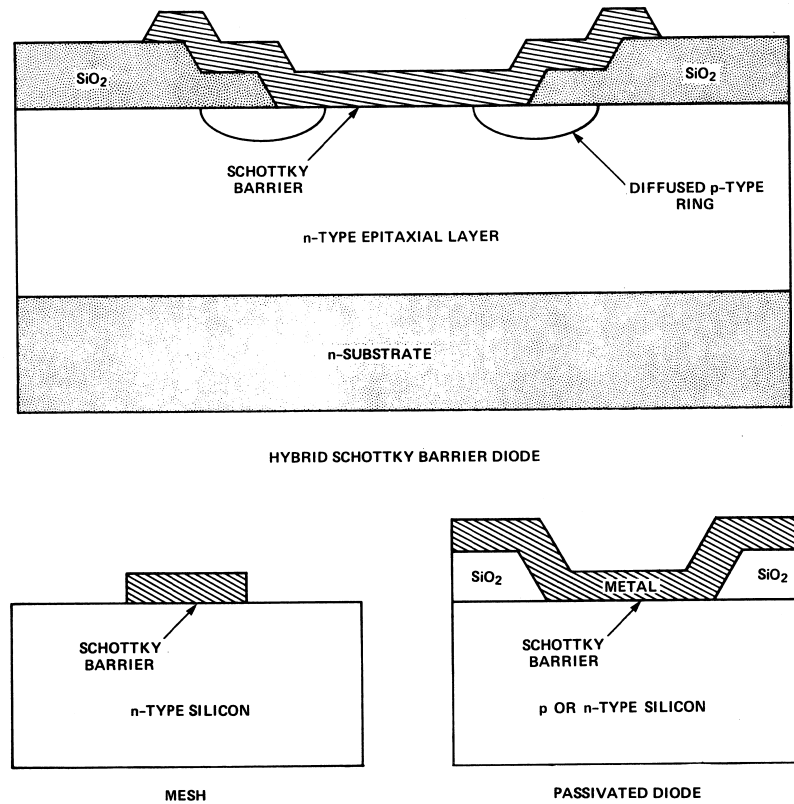


Figure 1. Three Types of Schottky Barrier Diodes

Mesh Diodes

Hewlett-Packard's patented mesh diode is made by depositing metal through a screen to the semiconductor surface. Many closely spaced diodes are created on the chip. The diode contacts are too small for thermocompression bonding. Contact is made by pressing a sharp metal point against one of the metal contacts on the diode. The large number of contacts on the chip provide a good yield to this operation.

Although the mesh contacts are too small for thermocompression bonding, they are not small enough for operation at high microwave frequencies. It is not possible to deposit reliable contact areas small enough for operation at frequencies above 7 GHz; in fact, the highest test frequency is 3 GHz. These mesh devices have model numbers in the series 5082-2300, 2400, 2500 and 2900.

Passivated Diodes

The problem of creating small area contacts was solved by the development of the passivated diode process. An oxide layer is formed over the entire silicon area. Then photolithographic techniques are used to open a small hole in the oxide.

The appropriate metal is deposited in the hole to make the small area Schottky barrier. Then gold is deposited to provide a larger surface for the thermocompression bond in ceramic packaged diodes (outlines 44 or 49) or for the pressure contact in glass packaged diodes (outline 15). (Silver is used for the 5082-2835.) Passivated diodes include the 5082-2835, the 5082-2750 series, zero bias detectors, and all diodes in outlines 44 and 49. These devices are used at frequencies up to 40 GHz.

This passivation process is also used in our beam lead diodes. The final gold layer becomes the beam lead itself. Beam lead diodes contain a nitride layer on the oxide to provide immunity from contaminants that could otherwise lead to reverse current drift. There is also a platinum layer between the barrier metal and the gold. This layer permits reliable operation at higher temperatures. Breakdown voltage for passivated type beam lead diodes is 4 volts minimum at 10 microamps.

Beam lead single diodes are included in the HSCH-5300 series, pairs in the HSCH-5500 series, and quads in the HSCH-5800. These beam lead diodes are also available in package outlines C2, C4, E1, H2, H4, J2, J3, and J4.

Hybrid Diodes

The breakdown voltage limitation was solved with the invention of the hybrid process. Hewlett-Packard's patented process combines a Schottky diode with a p-n junction, eliminating the premature breakdown of the passivated diode without sacrificing the picosecond switching response of the Schottky barrier. Breakdown voltage specifications as high as 70 volts are available. Hybrid diodes are numbered from 5082-2800 to 2826 and also 5082-2836. The beam lead version is 5082-2837.

The dual nature of the hybrid diode limits the lowest capacitance to a picofarad. This limits the high frequency guaranteed performance of these diodes to 2 GHz.

Hybrid chips are assembled in an inexpensive glass package (outline 15) with a C-shaped spring contact. The presence of the spring limits the speed of assembly and therefore the cost. The double stud package (outline 12) eliminates the spring by contacting the chip directly between two leads. A new hybrid chip was developed to withstand the higher temperatures used in this automatic assembly process. These low cost diodes are called HSCH-1001 or 1N6263.

The Offset Junction Schottky Diode

The increased preference of automatic wire bonding has driven the need for a Schottky chip that can withstand the stresses of thermosonic (vs. thermocompression) wire bonding. When the fragile Schottky barrier lies directly beneath the bond pad, as in conventional Schottky chips, cracking is likely to occur when sonic energy is applied directly above the active area. However, by offsetting the Schottky junction (see Figure 2), the bond pad will sit on a relatively thick oxide which acts as a stress dampener for the active area. This design, which keeps the bond pad symmetrically in the center of the chip, also allows much simpler pattern recognition when using automatic wire bonding.

The HSMS-0001 to HSMS-0013 Schottky diodes utilize this offset junction geometry and can replace most current center-junction hybrid chips. The offset-junction chip also has a larger gold bond pad (to 100 microns) and is silicon nitride-passivated to provide immunity to contaminants.

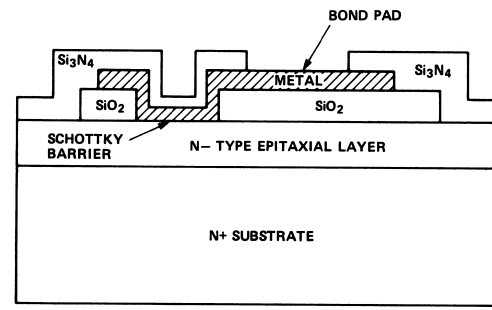


Figure 2. Offset-Junction Schottky Chip

The Height of the Schottky Barrier

The current-voltage characteristic of Schottky barrier diodes at room temperature is described by the following equation:

$$I = I_S \left(\exp\left(\frac{V - IR_S}{0.026} \right) - 1 \right)$$

For currents below 0.1 mA, the IR_S term may be neglected. On semi-log graph paper, as plotted in this catalog, the current graph will be a straight line with inverse slope 2.3 x 0.026 = 0.060 volts per cycle. All curves have the same slope, but not necessarily the same value of current for a given voltage. This is determined by the saturation current, I_S, and is related to the type of metal deposited on the silicon and to the treatment of the silicon surface layer. The term "barrier height" is related to the voltage required for a given current. Low voltage corresponds to low barrier.

Study of the forward characteristics in this catalog shows that the lowest barrier diode is the HSCH-3486 family of zero bias detectors. Detection at zero bias is possible for a range of barrier heights, but the voltage sensitivity is best for high barrier diodes. The sensitivity degrades for barrier heights less than that of the HSCH-3486. The other extreme is represented by medium barrier mixer diodes such as the 5082-2701. However, this barrier height corresponds to a zero bias junction resistance that requires a load resistance above 10 megohms. Zero bias detection with these diodes is limited to single frequency applications.

APPLICATIONS OF SCHOTTKY BARRIER DIODES

Schottky barrier diodes are useful in a wide variety of applications over a broad frequency range from digital to microwave.

General Purpose Diodes

The HSCH-1001 and similar diodes are useful for clipping, clamping, and speed up of transistor switching. These applications are discussed in Application Note 942, *Schottky Diodes for High Volume Low-Cost Applications,* and in several application bulletins described in the abstracts section of this catalog.

Mixers

The most sensitive receivers using Schottky barrier diodes make use of the nonlinear properties of the diode to produce a difference frequency by mixing the received signal with a local oscillator. Although this can be done with a single diode, it is more common to use multiple diodes in balanced or double balanced mixers. Balanced circuits reduce the effect of a noisy local oscillator and also reduce the level of high order mixing products that are not related to the desired input frequency. For multiple diode mixers, batch matched devices or matched pairs are available.

The most important property of mixer diodes is the noise figure — a measure of how small a signal can be received. The noise level for a perfect receiver is -114 dBm per MHz of bandwidth. A 6 dB noise figure mixer will degrade the noise level to -108 dBm per MHz. If the bandwidth of the receiver is 4 MHz the noise level is raised to -102 dBm. If a 10 dB signal to noise level is required for proper operation of the receiver, the sensitivity is -92 dBm. In this section of the catalog there are several groups of single diodes characterized for mixer applications. For stripline circuits the hermetic H-2, broadband C-2, and beam lead outlines are available. The best diodes are guaranteed to have a noise figure less than 6.0 dB at 9.375 GHz.

The other group of mixer diodes uses outline 15, glass package, for 2 and 3 GHz and outlines 44 and 49, ceramic packages, for 9.375 and 16 GHz. The best units have a 6 dB noise figure with the exception of the 16 GHz devices with a 6.5 dB prime unit.

Applications such as Doppler radar involving intermediate frequencies below 1 MHz will benefit by using the 5082-2400 or -2565 with its lower noise at these output frequencies. The additional noise (flicker noise) varies inversely with difference frequency and may differ as much as 20 dB from one diode type to another. Since the lowest capacitance (passivated) diodes (measured at 9.375 or 16 GHz) have the highest flicker noise, it is sometimes better to choose a Doppler mixer diode for lowest flicker noise rather than for lowest published noise figure.

Another type of mixer diode is the Schottky quad used for double balanced mixers. These quads are available in beam lead versions and in outlines E1, C4 and H4. These units contain a monolithic beam lead quad — four diodes connected in a ring configuration by gold deposited and plated on the wafer. Since the four diodes are made at the same time on the

same portion of a wafer, they are nearly identical and ideally suited for double balanced mixers.

In most cases both medium and low barrier models are available. The low barrier units have an impedance closer to 50 ohms. These models give better performance in broad band untuned circuits, particularly in those applications with local oscillator power below normal.

Detector Applications

For system applications with relaxed requirements on sensitivity the video detector receiver is a good alternative to the superheterodyne receiver. The sensitivity is degraded about 50 dB, but the circuitry is simplified and broad bandwidth is easily attained without the problem of tracking the local oscillator frequency.

The important parameters are tangential signal sensitivity (TSS) and voltage sensitivity (γ). Both of these, as well as video resistance (R_V), are guaranteed for these detector diodes. Typical detector performance is shown for mixer diodes, but detector diodes are designed for superior performance for this application.

Tangential signal sensitivity measures the ability of the diode to distinguish a small signal from noise. The name relates to a type of radar display with the bottom of the signal pulse tangent to the top of the noise level. There are subjective aspects to this measurement so that TSS measurement is now made with a voltmeter. The value depends on diode noise as well as detection capability.

In some applications, the detector is used as a monitor and the measurement level is well above the noise. For these applications, voltage sensitivity, voltage output for one microwatt input, is the important parameter.

The third specification, video resistance (R_V), is important for video amplifier and response time considerations. The video amplifier resistance, R_L, should be large compared to R_V because the maximum output voltage is degraded by the factor

$$\frac{R_L}{R_L + R_V}$$

However, response time is proportional to the RC product. If fidelity to pulse shape is important, the presence of pulses with steep edges requires a smaller value of load resistance. Sensitivity must be sacrificed for fidelity.

Zero bias Schottky detector diodes are available in the glass package (outline 15) and ceramic packages (outlines 44 and 49). Two types of metal to semiconductor junctions are used, resulting in two distinct ranges of junction resistance (video resistance). Since voltage sensitivity varies with resistance, the high resistance diodes have better voltage sensitivity. However, high resistance means higher noise so the TSS specifications are better for the low resistance diodes. All tests are done at 10 GHz.

The other type of detector diode (5082-2824 and -2750 series) requires a small forward bias. Production tests are made with 20 microamperes of bias which reduces the video resistance to about 1300 ohms. At zero bias the resistance is higher than for either one of the zero bias detectors. Although the statement has been made that high resistance corresponds to good sensitivity, the resistance is so high for these models (40 megohms for the 2750 series) that the sensitivity is degraded by normal load resistances. These diodes can be used without bias if the load resistance is comparable to the diode resistance. This is discussed in AN988 — All Schottky Diodes are Zero Bias Detectors.

The 5082-2824 diode is tested at 2 GHz. The 2750 series is supplied in outlines 15, 44, and 49 and tested at 10 GHz. The 5082-2787 is similar to the 2755 in outline 15 with the parameters sample tested to reduce cost.

Dynamic and Series Resistance

Schottky diode resistance may be expressed as series resistance, R_S, or as dynamic resistance, R_D. These two terms are related by the equation

$$R_D = R_S + R_j$$

where R_j is the resistance of the junction. Junction resistance of a diode with DC bias is quite accurately calculated by

$$R_j = 26/I_B \text{ where}$$

I_B is the bias current in milliamperes. The series resistance is independent of current.

The dynamic resistance is more easily measured. If series resistance is specified it is usually obtained by subtracting the calculated junction resistance from the measured dynamic resistance.

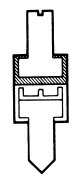
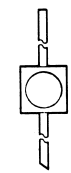
SCHOTTKY DIODE SELECTION GUIDE

Schottky barrier diodes are useful in a wide variety of applications over a broad frequency range from digital to microwave. To assist you in choosing the appropriate Schottky diode for your application, a selection guide has been prepared. Schottky diodes have been classified as general purpose diodes, mixers, and detectors. Further assistance is provided by selection tables specifying package styles and operating frequency band. All Schottky diode package outlines are shown in the Package Outline Index, beginning on page

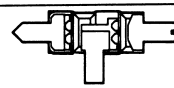
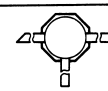
TABLE I. GENERAL PURPOSE SCHOTTKY SELECTION GUIDE

	Page
Glass Packaged Diodes	4-47
Surface Mount Diodes	4-37
Chips for Epoxy and Eutectic Die Attach	4-15

TABLE II. LOW BARRIER SCHOTTKY DIODES FOR MIXERS

						
Frequency	**Chip 01**	**Beam Lead 07**	**Ceramic/Epoxy C2**	**Hermetic H2**	**Ceramic Pill 44**	**Hermetic J-2**
to 12 GHz	5082-0013	HSCH-5336 HSCH-5338	5082-2774 5082-2794	5082-2765 5082-2785	5082-2295 5082-2297	HSCH-6332
12-18 GHz	5082-0013	HSCH-5332 HSCH-5334	5082-2774		5082-2295	HSCH-6330
to 140 GHz		HSCH-5330 HSCH-5340				

Beam Lead Pairs for Balanced Mixers

		
Frequency	**Beam Lead 04**	**Hermetic J-3**
to 12 GHz	HSCH-5536 HSCH-5534	HSCH-6530
12-18 GHz	HSCH-5532 HSCH-5538	HSCH-6532
to 140 GHz	HSCH-5530 HSCH-5531 HSCH-5540	

Beam Lead Quads for Double Balanced Mixers

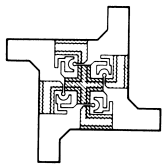
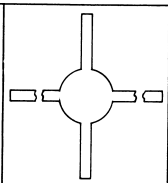
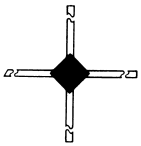
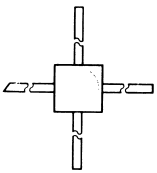
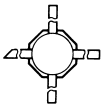
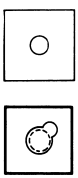
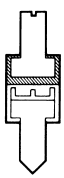
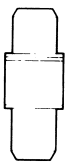
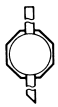
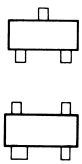
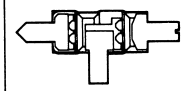
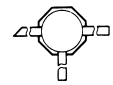
Frequency	 Beam Lead 03	 Low Cost E-1	 Broadband C4	 Hermetic H-4	 Hermetic J-4
to 2 GHz	HSCH-5836	5082-2831	5082-2271	5082-2231	HSCH-6832
2-4 GHz	HSCH-5836		5082-2271	5082-2231	HSCH-6832
4-8 GHz	HSCH-5836		5082-2272	5082-2233	HSCH-6832
8-12 GHz	HSCH-5836		5082-2279		HSCH-6832
12-18 GHz	HSCH-5832		5082-2280		HSCH-6830
to 26 GHz	HSCH-5830				

TABLE III. MEDIUM BARRIER SCHOTTKY DIODES FOR MIXERS

Frequency	 Chip 01	 Beam Lead 07	 Glass Package 15	 Ceramic/ Epoxy C2	 Hermetic H2	 Ceramic Pill 44	 Double Stud 49	 Hermetic J-2	 Surface Mount 23, 143
to 2 GHz	5082-0087 HSMS-0002	HSCH-5316	5082-2817 5082-2400 5082-2350	5082-2210	5082-2203	5082-2707	5082-2712	HSCH-6312	HSMS-28XX
2-4 GHz	5082-0023	HSCH-5316	5082-2565 5082-2520	5082-2210	5082-2203	5082-2707	5082-2712	HSCH-6312	
4-12 GHz	5082-0023	HSCH-5316 HSCH-5318		5082-2207 5082-2209	5082-2200 5082-2202	5082-2701 5082-2702	5082-2713 5082-2711	HSCH-6312	
12-18 GHz	5082-0029	HSCH-5312 HSCH-5314		5082-2207		5082-2273	5082-2273	HSCH-6310	
to 140 GHz		HSCH-5310 HSCH-5320						HSCH-6310	

Beam Lead Pairs for Balanced Mixers

Frequency	 Beam Lead 04	 Hermetic J-3
to 12 GHz	HSCH-5514 HSCH-5516	HSCH-6512
12-18 GHz	HSCH-5518 HSCH-5512	HSCH-6510
to 140 GHz	HSCH-5510 HSCH-5511 HSCH-5520	

Beam Lead Quads for Double Balanced Mixers

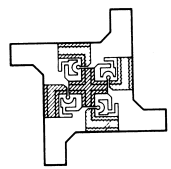
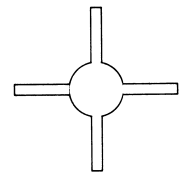
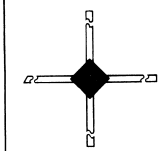
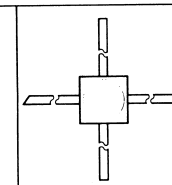
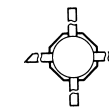
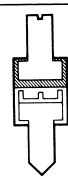
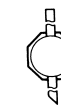
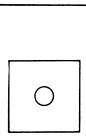
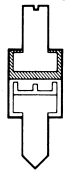
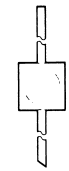
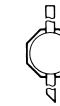
Frequency	 Beam Lead 03	 Low Cost E-1	 Broadband C4	 Hermetic H-4	 Hermetic J-4
to 2 GHz	HSCH-5816	5082-2830	5082-2291	5082-2263	HSCH-6812
2-4 GHz	HSCH-5816	5082-2277	5082-2291	5082-2263	HSCH-6812
4-8 GHz	HSCH-5816	5082-2277	5082-2292	5082-2263	HSCH-6812
8-12 GHz	HSCH-5816		5082-2294		HSCH-6812
12-18 GHz	HSCH-5812		5082-2294		HSCH-6810
to 26 GHz	HSCH-5810				

TABLE IV. DETECTOR SELECTION GUIDE

Bias Required

 Chip 01	 Beam Lead 07	 Glass Package 15	 Ceramic/ Epoxy C2	 Hermetic H2	 Ceramic Pill 44	 Double Stud 49	 Hermetic J-2
5082-0009	HSCH-5300 Series	5082-2824 5082-2755 5082-2787	5082-2207/09 5082-2774/94	5082-2200/03 5082-2765/85	5082-2750	5082-2751	HSCH-6310, 6312, 6330, 6332

Zero Bias

							
Chip 01	**Beam Lead 07**	**Glass Package 15**	**Ceramic/ Epoxy C2**	**Hermetic H2**	**Ceramic Pill 44**	**Double Stud 49**	**Hermetic J-2**
5082-0013	HSCH-5330 Series	5082-3486	5082-2774 5082-2794	5082-2765 5082-2785	HSCH-3207	HSCH-3206	HSCH-6330, 6332

SCHOTTKY BARRIER DIODE ALPHANUMERIC INDEX

Part No.	Description	Page Number		
		Commercial Data Sheet	Standard Hi-Rel Data Sheet	Reliability Data Sheet
HSCH-0812	Hi-Rel Zero Bias Schottky (HSCH-3486)		4-103	
HSCH-0813	Matched Pair HSCH-0814 (5082-2401)		4-87	
HSCH-0814	Hi-Rel Schottky Barrier Diode (5082-2400)		4-87	
HSCH-0815	Matched Pair HSCH-0816 (5082-2306)		4-87	
HSCH-0816	Hi-Rel Schottky Barrier Diode (5082-2301)		4-87	
HSCH-1001	General Purpose Schottky Diode (1N6263)	4-47, 5-6		
HSCH-1111	Hi-Rel Schottky Chip		4-79	
HSCH-3206	Zero Bias Detector Schottky Diode	4-70		4-120
HSCH-3207	Zero Bias Detector Schottky Diode	4-70		4-120
HSCH-3486	Zero Bias Detector Schottky Diode	4-70	4-103	4-118
HSCH-5310	Medium V_F Schottky Beam Lead	4-18	4-81	4-112, 114
HSCH-5311	Batch Matched HSCH-5310	4-18	4-81	4-112, 114
HSCH-5312	Medium V_F Schottky Beam Lead	4-18	4-81	4-112, 114
HSCH-5313	Batch Matched HSCH-5312	4-18	4-81	4-112, 114
HSCH-5314	Ku Band Medium V_F Schottky Beam Lead	4-18	4-81	4-112, 114
HSCH-5315	Batch Matched HSCH-5314	4-18	4-81	4-112, 114
HSCH-5316	Medium V_F Schottky Beam Lead	4-18	4-81	4-112, 114
HSCH-5317	Batch Matched HSCH-5316	4-18	4-81	4-112, 114
HSCH-5318	X-Band Medium V_F Schottky Beam Lead	4-18	4-81	4-112, 114
HSCH-5319	Batch Matched HSCH-5318	4-18	4-81	4-112, 114
HSCH-5320	Medium Barrier Beam Lead Schottky Diode	4-18	4-81	4-112, 114
HSCH-5321	Batch Matched HSCH-5320	4-18	4-81	4-112, 114
HSCH-5330	Low V_F Schottky Beam Lead	4-18	4-81	4-112, 114
HSCH-5331	Batch Matched HSCH-5330	4-18	4-81	4-112, 114
HSCH-5332	Low V_F Schottky Beam Lead	4-18	4-81	4-112, 114
HSCH-5333	Batch Matched HSCH-5332	4-18	4-81	4-112, 114
HSCH-5334	Ku Band Low V_F Schottky Beam Lead	4-18	4-81	4-112, 114
HSCH-5335	Batch Matched HSCH-5334	4-18	4-81	4-112, 114
HSCH-5336	Low V_F Schottky Beam Lead	4-18	4-81	4-112, 114
HSCH-5337	Batch Matched HSCH-5336	4-18	4-81	4-112, 114
HSCH-5338	X-Band Low V_F Schottky Beam Lead	4-18	4-81	4-112, 114
HSCH-5339	Batch Matched HSCH-5338	4-18	4-81	4-112, 114
HSCH-5340	Low Barrier Beam Lead Schottky Diode	4-18	4-81	4-112, 114
HSCH-5341	Batch Matched HSCH-5321	4-18	4-81	4-112, 114
HSCH-5510	Ku Band Medium V_F Schottky Beam Lead Pair	4-25	4-83	4-112, 114

Part No.	Description	Page Number		
		Commercial Data Sheet	Standard Hi-Rel Data Sheet	Reliability Data Sheet
HSCH-5511	Medium V_F Schottky Beam Lead Pair	4-25	4-83	4-112, 114
HSCH-5512	Medium Barrier Beam Lead Schottky Diode	4-25	4-83	4-112, 114
HSCH-5514	Medium Barrier Beam Lead Schottky Diode	4-25	4-83	4-112, 114
HSCH-5516	Medium Barrier Beam Lead Schottky Diode	4-25	4-83	4-112, 114
HSCH-5518	Medium Barrier Beam Lead Schottky Diode	4-25	4-83	4-112, 114
HSCH-5520	Medium Barrier Beam Lead Schottky Diode	4-25	4-83	4-112, 114
HSCH-5530	Ku Band Low V_F Schottky Beam Lead Pair	4-25	4-83	4-112, 114
HSCH-5531	Low V_F Schottky Beam Lead Pair	4-25	4-83	4-112, 114
HSCH-5532	Low Barrier Beam Lead Schottky Diode	4-25	4-83	4-112, 114
HSCH-5534	Low Barrier Beam Lead Schottky Diode	4-25	4-83	4-112, 114
HSCH-5536	Low Barrier Beam Lead Schottky Diode	4-25	4-83	4-112, 114
HSCH-5538	Low Barrier Beam Lead Schottky Diode	4-25	4-83	4-112, 114
HSCH-5540	Low Barrier Beam Lead Schottky Diode	4-25	4-83	4-112, 114
HSCH-5810	Medium Barrier Beam Lead Schottky Diode	4-25	4-85	4-112, 114
HSCH-5812	Medium Barrier Beam Lead Schottky Diode	4-25	4-85	4-112, 114
HSCH-5816	Medium Barrier Beam Lead Schottky Diode	4-25	4-85	4-112, 114
HSCH-5830	Low Barrier Beam Lead Schottky Diode	4-25	4-85	4-112, 114
HSCH-5832	Low Barrier Beam Lead Schottky Diode	4-25	4-85	4-112, 114
HSCH-5836	Low Barrier Beam Lead Schottky Diode	4-25	4-85	4-112, 114
HSCH-5918 *	Beam Lead Schottky Diode Bridge Quad	4-34		4-112, 114
HSCH-5938 *	Beam Lead Schottky Diode Bridge Quad	4-34		4-112, 114
HSCH-5958 *	Beam Lead Schottky Diode Bridge Quad	4-34		4-112, 114
HSCH-6310	Medium Barrier Hermetic Schottky Diode	4-51		4-112, 114
HSCH-6312	Medium Barrier Hermetic Schottky Diode	4-51		4-112, 114
HSCH-6330	Low Barrier Hermetic Schottky Diode	4-51		4-112, 114
HSCH-6332	Low Barrier Hermetic Schottky Diode	4-51		4-112, 114
HSCH-6510	Medium Barrier Hermetic Schottky Diode	4-51		4-112, 114
HSCH-6512	Medium Barrier Hermetic Schottky Diode	4-51		4-112, 114
HSCH-6530	Low Barrier Hermetic Schottky Diode	4-51		4-112, 114
HSCH-6532	Low Barrier Hermetic Schottky Diode	4-15		4-106
HSCH-6810	Medium Barrier Hermetic Schottky Diode	4-15		4-106
HSCH-6812	Medium Barrier Hermetic Schottky Diode	4-15		4-106
HSCH-6830	Low Barrier Hermetic Schottky Diode	4-15		4-106
HSCH-6832	Low Barrier Hermetic Schottky Diode	4-15		4-106
HSMS-0001	Offset Junction Schottky Barrier Chip	4-15		4-106
HSMS-0002	Offset Junction Schottky Barrier Chip	4-37		4-106
HSMS-0003	Offset Junction Schottky Barrier Chip	4-37		4-106
HSMS-0011	Batch Matched HSMS-0001	4-37		4-106
HSMS-0012	Batch Matched HSMS-0002	4-37		4-106
HSMS-0013	Batch Matched HSMS-0003	4-37		4-106
HSMS-2800	Surface Mount Schottky Barrier Diode	4-42		4-106
HSMS-2801	Surface Mount Schottky Barrier Diode	4-42		4-106
HSMS-2802	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2803	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2804	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2805 *	Surface Mount Schottky Barrier Diode	4-42		4-106
HSMS-2808 *	Surface Mount Schottky Barrier Diode	4-42		4-106
HSMS-2810	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2811	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2812	Surface Mount Schottky Barrier Diode	4-37		4-106

Part No.	Description	Page Number		
		Commercial Data Sheet	Standard Hi-Rel Data Sheet	Reliability Data Sheet
HSMS-2814	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2818*	Surface Mount Schottky Barrier Diode	4-42		4-106
HSMS-2820	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2821	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2822	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2823	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2824	Surface Mount Schottky Barrier Diode	4-37		4-106
HSMS-2825*	Surface Mount Schottky Barrier Diode	4-42		4-106
HSMS-2828*	Surface Mount Schottky Barrier Diode	4-42		4-106
HSMS-2840	Low Cost Surface Mount Schottky Diode	4-37, 5-2		4-106
HSMS-2841	Low Cost Surface Mount Schottky Diode	4-37, 5-2		4-106
JAN 1N5711	MIL-S-19500/444 Schottky Diode		4-89	
JAN 1N5712	MIL-S-19500/445 Schottky Diode		4-93	
JANTX 1N5711	MIL-S-19500/444 Schottky Diode		4-89	
JANTX 1N5712	MIL-S-19500/445 Schottky Diode		4-93	
JANTXV 1N5711	MIL-S-19500/444 Schottky Diode		4-89	
JANTXV 1N5712	MIL-S-19500/445 Schottky Diode		4-93	
TXVB-2810	Hi-Rel 5082-2810		4-97	
TXVB-2811	Hi-Rel 5082-2811		4-97	
TXVB-2835	Hi-Rel 5082-2835		4-100	
TXVW-5300 Series	Hi-Rel HSCH-5300 Beam Leads		4-81	
TXVW-5500 Series	Hi-Rel HSCH-5500 Beam Leads		4-83	
TXVW-5800 Series	Hi-Rel HSCH-5800 Beam Leads		4-85	
1N5711	H V Gen. Purpose Schottky Diode (5082-2800)	4-47	4-89	4-110
1N5712	General Purpose Schottky Diode (5082-2810)	4-47	4-93	4-110
1N6263	General Purpose Schottky Diode (HSCH-1001)	4-47, 5-6		
5082-0009	X-Band Schottky Detector Chip	4-15		4-122
5082-0013	Low V_F Mixer/Zero Bias Detector Shottky Chip	4-15		4-120
5082-0023	X-Band Schottky Mixer Chip	4-15		4-120
5082-0024	High Voltage Switching Schottky Chip	4-15		4-110
5082-0029	Ku-Band Schottky Mixer Chip	4-15		4-120
5082-0041	X-Band Schottky Mixer Chip	4-15		4-120
5082-0057	General Purpose Schottky Diode Chip	4-15		4-110
5082-0058	General Purpose Schottky Diode Chip	4-15		4-110
5082-0087	General Purpose Schottky Chip	4-15		4-110
5082-0094	General Purpose Schottky Diode Chip	4-15	4-79	4-110
5082-0097	General Purpose Schottky Chip	4-15		4-110
5082-2080	Batch Matched 5082-2835 Schottky	4-47		4-110
5082-2200	Hermetic Stripline Schottky Diode	4-55		4-112
5082-2201	Batch Matched 5082-2200	4-55		4-112
5082-2202	Hermetic Stripline Schottky Diode	4-55		4-112
5082-2203	Batch Matched 5082-2202	4-55		4-112
5082-2207	Stripline Schottky Diode	4-55		4-112
5082-2208	Batch Matched 5082-2207	4-55		4-112
5082-2209	Stripline Schottky Diode	4-55		4-112
5082-2210	Batch Matched 5082-2209	4-55		4-112
5082-2231	Low V_F Hermetic Stripline Schottky Quad	4-60		4-116
5082-2233	Low V_F Hermetic Stripline Schottky Quad	4-60		4-116
5082-2263	Hermetic Stripline Schottky Ring Quad	4-60		4-116
5082-2271	Low V_F Stripline Schottky Diode Quad	4-60		4-116

Part No.	Description	Page Number		
		Commercial Data Sheet	Standard Hi-Rel Data Sheet	Reliability Data Sheet
5082-2272	Low V_F Stripline Schottky Diode Quad	4-60		4-116
5082-2273	Ku Band Schottky Mixer Diode	4-63		4-120
5082-2274	Matched pair of 5082-2273	4-63		4-120
5082-2277	C-Band Stripline Schottky Ring Quad	4-60		4-116
5082-2279	Low V_F Broadband Stripline Schottky Quad	4-60		4-116
5082-2280	Low V_F Broadband Stripline Schottky Quad	4-60		4-116
5082-2291	Stripline Schottky Ring Quad	4-60		4-116
5082-2292	Stripline Schottky Ring Quad	4-60		4-116
5082-2294	Stripline Schottky Ring Quad	4-60		4-116
5082-2295	X-Band Low V_F Schottky Diode	4-63	4-87	4-120
5082-2296	Matched pair of 5082-2295	4-63		4-120
5082-2297	X-Band Low V_F Schottky Diode	4-63		4-120
5082-2298	Matched pair of 5082-2297	4-63		4-120
5082-2301	Schottky Barrier Diode	4-47		4-118
5082-2302	Schottky Barrier Diode	4-47	4-87	4-118
5082-2303	Schottky Barrier Diode	4-47		4-118
5082-2305	Schottky Barrier Diode	4-47		4-118
5082-2306	Matched pair of 5082-2301	4-47		4-118
5082-2308	Matched pair of 5082-2303	4-47		4-118
5082-2350	Schottky Barrier Diode	4-63		4-118
5082-2351	Matched pair of 5082-2350	4-63		4-118
5082-2356	Matched Encapsulated Bridge Quad	4-47		4-118
5082-2370	Matched Quad of 5082-2303 Unconnected	4-47		4-118
5082-2396	Matched Encapsulated Ring Quad	4-47		4-118
5082-2400	Schottky Barrier Diode	4-63	4-87	4-118
5082-2401	Matched pair of 5082-2400	4-63	4-87	4-118
5082-2520	Schottky Barrier Diode	4-63		4-118
5082-2521	Matched pair of 5082-2520	4-63		4-118
5082-2565	Schottky Barrier Diode	4-63		4-118
5082-2566	Matched pair of 5082-2565	4-63		4-118
5082-2701	X-Band Schottky Mixer Diode	4-63		4-120
5082-2702	X-Band Schottky Mixer Diode	4-63		4-120
5082-2706	Matched pair of 5082-2701	4-63		4-120
5082-2707	Matched pair of 5082-2702	4-63		4-120
5082-2711	X-Band Schottky Mixer Diode	4-63		4-120
5082-2712	Matched pair of 5082-2711	4-63		4-120
5082-2713	X-Band Schottky Mixer Diode	4-63		4-120
5082-2714	Matched pair of 5082-2713	4-63		4-120
5082-2723	Ku Band Schottky Mixer Diode	4-63		4-120
5082-2724	Matched pair of 5082-2723	4-63		4-120
5082-2750	Schottky Detector Diode	4-74		4-122
5082-2751	Schottky Detector Diode	4-74		4-122
5082-2755	Schottky Detector Diode	4-74		4-118
5082-2765	Low V_F Hermetic Stripline Schottky	4-55		4-112
5082-2766	Batch Matched 5082-2765	4-55		4-112
5082-2774	Low V_F Stripline Schottky Diode	4-55		4-112
5082-2775	Batch Matched 5082-2774	4-55		4-112
5082-2785	Low V_F Hermetic Stripline Schottky	4-55		4-112
5082-2786	Batch Matched 5082-2785	4-55		4-112
5082-2787	Schottky Detector Diode	4-74		4-118

Part No.	Description	Page Number		
		Commercial Data Sheet	Standard Hi-Rel Data Sheet	Reliability Data Sheet
5082-2794	Low V_F Stripline Schottky Diode	4-55		4-112
5082-2795	Batch Matched Pair of 5082-2794	4-55		4-112
5082-2800	H V Gen. Purpose Schottky Barrier Diode(1N5711)	4-47		4-110
5082-2804	Matched Pair of 5082-2800 Unconnected	4-47		4-110
5082-2805	Matched Quad 5082-2800 Unconnected	4-47		4-110
5082-2810	General Purpose Schottky Diode (1N5712)	4-47	4-97	4-110
5082-2811	General Purpose Schottky Diode	4-47	4-97	4-110
5082-2813	Matched Bridge Quad 5082-2811 Encapsulated	4-47		4-110
5082-2814	Matched Ring Quad 5082-2811 Encapsulated	4-47		4-110
5082-2815	Matched Quad 5082-2811 Unconnected	4-47		4-110
5082-2817	Schottky Barrier Diode	4-63		4-110
5082-2818	Matched pair of 5082-2817	4-63		4-110
5082-2824	Schottky Barrier Diode	4-74		4-110
5082-2826	Batch Matched Diode 5082-2811	4-47		4-110
5082-2830	Monolithic Matched Schottky Diode Ring Quad	4-60		4-116
5082-2831	Low V_F Monolithic Matched Schottky Quad 5082-9697	4-60		4-116
5082-2835	Low Offset Schottky Diode	4-47	4-100	4-110
5082-2836	Batch Matched Diode 5082-2800	4-47		4-110
5082-2837	Schottky Diode Beam Lead	4-23		4-112, 114
5082-2900	Schottky Barrier Diode	4-47		4-118
5082-2912	Match pair of 5082-2900 Unconnected	4-47		4-118
5082-2970	Matched Quad 5082-2900 Unconnected	4-47		4-118
5082-2997	Matched Bridge Quad 5082-2900 Encapsulated	4-47		4-118
5082-9394†	Beam Lead Quad	—		4-116
5082-9395†	Beam Lead Quad	—		4-116
5082-9396†	Beam Lead Quad	—		4-116
5082-9397†	Beam Lead Quad	—		4-116
5082-9398†	Beam Lead Quad	—		4-116
5082-9399†	Beam Lead Quad	—		4-116
5082-9696†	Beam Lead Quad	—		4-116
5082-9697†	Beam Lead Quad	—		4-116
5082-9891	X-Band Schottky Detector Chip	4-15		4-122

† Consult Factory
* Available soon

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SCHOTTKY BARRIER CHIPS FOR HYBRID INTEGRATED CIRCUITS

5082-0009	5082-0094
5082-0013	5082-0097
5082-0023	5082-9891
5082-0024	HSMS-0001
5082-0029	HSMS-0011
5082-0041	HSMS-0002
5082-0057	HSMS-0012
5082-0058	HSMS-0003
5082-0087	HSMS-0013

Features

THERMOCOMPRESSION/THERMOSONICALLY BONDABLE

GOLD METALLIZATION

SILICON NITRIDE PASSIVATION

UNIFORM ELECTRICAL CHARACTERISTICS

BATCH MATCHED VERSIONS AVAILABLE

PLANAR CONSTRUCTION

AVAILABLE IN MANY ELECTRICAL SELECTIONS

IDEAL FOR HYBRID INTEGRATED CIRCUITS

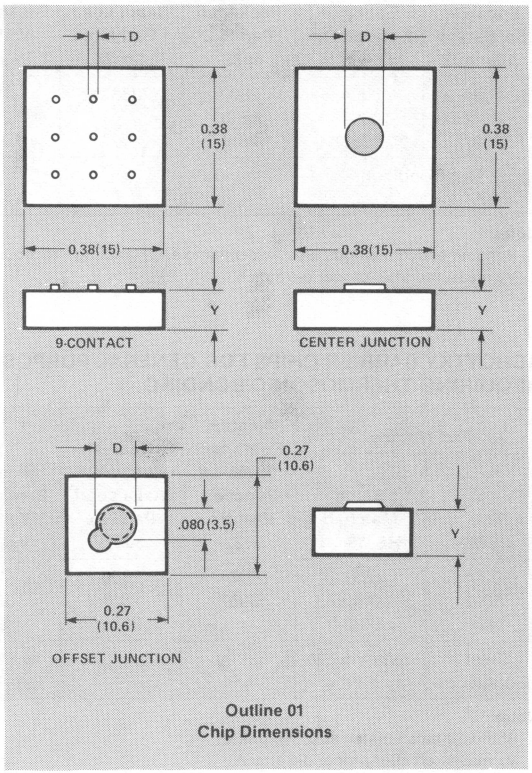
HIGH RELIABILITY LOT QUALIFICATION TESTING AVAILABLE

Description/Applications

These Schottky chips are designed for hybrid applications at DC through K-band frequencies. The passivated planar construction of these Schottky chips provides a wide temperature range capability combined with broad bandwidth performance.

A variety of chips are provided which are optimized for various analog and digital applications. Typical applications of Schottky chips are mixing, detecting, switching, gating, sampling, and wave shaping.

The HSMS-00XX (offset junction) series Schottky diode chips are specifically designed for analog and digital hybrid applications requiring thermosonic or thermocompression bonding techniques. The large bonding pad and offset junction allows easy bonding without the penalty of a large parasitic capacitance. The top metallization is a layer of gold deposited on adhesive metal layers for a tarnish-free surface that allows either thermosonic or thermocompression bonding techniques. The bottom metallization is also gold, suitable for epoxy or eutectic die attach methods.



Outline 01
Chip Dimensions

	PART NUMBER				
	9-CONTACT	CENTER JUNCTION			OFFSET JUNCTION
DIMENSION	5082-0041 -9891	5082-0024 -0094	5082-0057 -0058 -0087 -0097	5082-0009 -0013 -0023 -0029	HSMS-000X -00XX
D	0.02 (0.80)*	0.10 (4)	0.08 (3)	0.02 (0.80)*	0.10 (4)
Y	0.10 (4)	0.13 (5)	0.13 (5)	0.10 (4)	0.13 (5)

NOTES:
1. Dimensions in millimeters and (1/1000 inch).
2. Dimension tolerance ±0.03 (1), except * where it is ±0.006 (0.2).
3. Top contact is anode except 5082-0009, where top is cathode.
4. All contact metallization is gold.

Maximum Ratings

Junction Operating and Storage Temperature

5082-0024, -0057, -0058, -0087, -0094, -0097, HSMS-00XX ..... -65°C to +200°C

5082-0009, -0013, -0023, -0029, -0041, -9891 ..... -65°C to +150°C

Power Dissipation @ T_A = 25°C ..... 250 mW
Measured in an infinite heat sink derated linearly to zero at maximum rated temperature.

I_F max (1 μs pulse) ..... 1 Amp

Operation in excess of any one of these conditions may result in permanent damage.

Electrical Specifications at T = 25°C



SCHOTTKY BARRIER CHIPS FOR GENERAL PURPOSE APPLICATIONS

Part Number 5082-		Nearest Equivalent Packaged Part No. 5082-	Nearest Equivalent Beam Lead Part No. 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)[2]	Maximum Forward Voltage V_F (mV) @ I_F (mA)[2]	Maximum Capacitance C_T (pF)	Maximum Reverse Leakage Current I_R (nA) @ V_R (V)
Epoxy or Solder Die Attach[1]	Epoxy or Eutectic Die Attach[1]							
0024	0094	2800	2837	70		1.0 15	1.7	200 50
0087	0057	2810		20	410	1.0 35	1.0	100 15
0097	0058	2811		15		1.0 20	1.1	100 8
Test Conditions				I_R = 10 μA	I_F = 1 mA		V_R = 0 V f = 1 MHz	

Notes:
1. Recommended methods. See "Assembling and Handling Procedures" for definitions.
2. V_F measured after proper die attach.



SCHOTTKY BARRIER CHIPS FOR GENERAL PURPOSE APPLICATIONS REQUIRING THERMOSONIC BONDING

Part Number		Nearest Equivalent Centered Junction Part No. 5082-	Nearest Equivalent Axial Lead Part No. 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)[2]	Maximum Forward Voltage V_F (mV) @ I_F (mA)[2]	Maximum Capacitance C_T (pF)	Maximum Reverse Leakage Current I_R (nA) @ V_R (V)
HSMS-	Batch Matched HSMS-[1]							
0001	0011	0024	2800	70	410	1.0 15	1.7	200 50
0002	0012	0087	2810	20	410	1.0 35	1.1	100 15
0003	0013		2835	8*	340	0.5 10	0.8	100 1
Test Conditions	ΔV_F = 15 mV I_F = 1 mA			I_R = 10 μA *I_R = 100 μA	I_F = 1 mA		V_R = 0 V f = 1.0 MHz	

Notes:
1. Standard batch match size, 100 units.
2. V_F measured after proper die attach.



SCHOTTKY BARRIER CHIPS FOR MIXING AND DETECTING

Part Number 5082-		Nearest Equivalent Packaged Part No. 5082-	Nearest Equivalent Beam Lead Part No. HSCH-	Maximum Junction Capacitance C_T (pF)	Typical Parameters	
Chip	9 Contact Chip				Noise Figure NF (dB)[1]	Tangential Sensitivity T_{SS}(dBm)
0023	0041	2713	5316	0.18	6.0	-54
0029		2721	5312	0.13	6.0 7.0**	-54
0013		HSCH-3206*	5332	0.18	6.0	-42†
		2295				-54
0009	9891	2750		0.10	7.0	-55
Test Conditions		*Zero Bias		V_R = 0 V f = 1 MHz	f = 9.375 GHz **f = 16 GHz	f = 10 GHz BW = 2 MHz I_{BIAS} = 20 μA †Zero Bias

Note:
1. NF includes 1.5 dB for the IF amplifier.

Assembly and Handling Procedures for Schottky Chips

1. Storage

Devices should be stored in a dry nitrogen purged dessicator or equivalent.

2. Cleaning

If required, surface contamination may be removed with electronic grade solvents such as freon (T.F. or T.M.C.), acetone, deionized water, and methanol used singularly or in combinations. Typical cleaning times per solvent are one to three minutes. DI water and methanol should be used (in that order) in the final cleans. Final drying can be accomplished by placing the cleaned dice on clean filter paper and drying with an infrared lamp for 5-10 minutes. Acids such as hydroflouric (HF), nitric (HNO_3) and hydrochloric (HCl) should not be used.

The effects of cleaning methods/solutions should be verified on small samples prior to submitting the entire lot.

Following cleaning, dice should be either used in assembly (typically within a few hours) or stored in clean containers in a reducing atmosphere or a vacuum chamber.

3. Die Attach

a. Eutectic —

Eutectic die attach can be accomplished by "scrubbing" the die without a preform and using the gold on the header to combine with the silicon in the die. Temperature is approximately 400°C, with heating times of 5-10 seconds. (Note—times and temperature utilized may vary depending on the type, composition, and heat capacity of the header or substrate used.) This method is recommended for the HSMS-00XX series.

b. Epoxy

For epoxy die-attach, conductive silver- or gold-filled epoxies are recommended. This method can be used for all Hewlett-Packard Schottky chips.

c. Solder

Solder preforms with melting points less than 400°C are recommended, e.g. gold-tin (approximately 280°C melting point), Au-Si (376°C melting point), various Sn-Pb, etc.

For further reference on die-attach techniques, see Application Note 974 "Die Attach and Bonding Techniques".

3. Wire Bonding

Thermocompression is the recommended bonding method for the 9 point contact and center-junction chips. Thermosonic or thermocompression wire bonding is recommended for the offset-junction Schottky chips. Suggested wire is pure gold, 0.7 to 1.5 mil diameter.

HEWLETT PACKARD

BEAM LEAD SCHOTTKY DIODES FOR MIXERS AND DETECTORS (1-26 GHz)

HSCH-5300 SERIES

Features

PLATINUM TRI-METAL SYSTEM
High Temperature Stability

SILICON NITRIDE PASSIVATION
Stable, Reliable Performance

LOW NOISE FIGURE
Guaranteed 7.5 dB at 26 GHz

HIGH UNIFORMITY
Tightly Controlled Process Insures Uniform RF Characteristics

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

LOW CAPACITANCE
0.10 pF Max. at 0 V

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

POLYMIDE SCRATCH PROTECTION

Description

These beam lead diodes are constructed using a metal-semiconductor Schottky barrier junction. Advanced epitaxial techniques and precise process control insure uniformity and repeatability of this planar passivated microwave semiconductor. A nitride passivation layer provides immunity from contaminants which could otherwise lead to I_R drift.

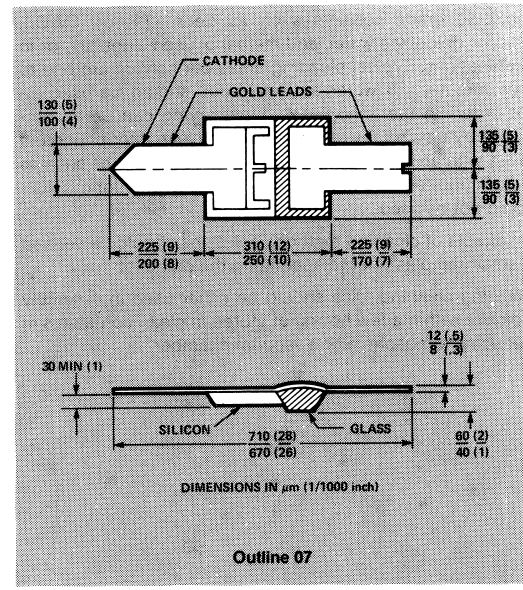
The HP beam lead process allows for large beam anchor pads for rugged construction (typical 6 gram pull strength) without degrading capacitance.

Maximum Ratings

Pulse Power Incident at T_A = 25° C ..... 1 W
Pulse Width = 1 μs, Du = 0.001
CW Power Dissipation at T_A = 25° C ..... 150 mW
Measured in an infinite heat sink derated linearly to zero at maximum rated temperature.
T_{OPR} — Operating Temperature Range ..... −65° C to +175° C
T_{STG} — Storage Temperature Range ..... −65° C to +200° C
Minimum Lead Strength ..... 4 grams pull on any lead
Diode Mounting Temperature ..... +350° C for 10 sec. max.
These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Bonding and Handling Procedures

See page 4-36.



Outline 07

Applications

The beam lead diode is ideally suited for use in stripline or microstrip circuits. Its small physical size and uniform dimensions give it low parasitics and repeatable RF characteristics through K-band.

The basic medium barrier devices in this family are DC tested HSCH-5310, -5312, and -5316. Batch matched versions are available as the HSCH-5311, -5313, and -5317. Equivalent low barrier devices are HSCH-5330, -5332 and -5336. Batch matched versions are available as HSCH-5331, -5333, and -5337.

For applications requiring guaranteed RF performance up to 26 GHz, the HSCH-5320 is selected with batch match units available as the HSCH-5321. The HSCH-5318 is selected for 6.2 dB maximum noise figure at 9.375 GHz, with RF batch match units available as the HSCH-5319. The HSCH-5314 is rated at 7.2 dB maximum noise figure at 16 GHz with RF batch match units available as the HSCH-5315.

For guaranteed low-barrier RF performance to 26 GHz, the HSCH-5340 is selected with batch match units available as the HSCH-5341. The HSCH-5338 and -5334 are selected for noise figure 6.2 dB maximum at 9.375 and 7.2 dB maximum at 16 GHz respectively. Batch matched versions are available as the HSCH-5339 and -5335.

Electrical Specifications for RF tested Diodes at $T_A = 25°C$

Part Number HSCH-	Batch* Matched HSCH-	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	IF Impedance Z_{IF} (Ω) Max.	Maximum SWR	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Maximum Total Capacitance C_T (pF)	Maximum Forward Voltage V_F (mV)
5318	5319	Medium	6.2 at 9.375 GHz	200	400	1.5:1	4	12	0.25	500
5314	5315		7.2 at 16 GHz					16	0.15	
5320	5321		7.5 at 26 GHz					20	0.10	
5338	5339	Low	6.2 at 9.375 GHz	150	350	1.5:1	4	12	0.25	375
5334	5335		7.2 at 16 GHz					16	0.15	
5340	5341		7.5 at 26 GHz					20	0.10	
Test Conditions	$\Delta NF \leq 0.3dB$ $\Delta Z_{IF} \leq 25\Omega$		DC Load Resistance = 0Ω L.O. Power = 1 mW I_F = 30 MHz, 1.5 dB NF				$I_R \leq 10\ \mu A$	I_F = 5 mA	V_R = 0V f = 1 MHz	I_F = 1 mA

*Minimum batch size 20 units.
Note: $C_T = C_J + 0.02$ pf

Electrical Specifications for DC tested Diodes at $T_A = 25°C$

Part Number HSCH-	Batch* Matched HSCH-	Barrier	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Maximum Total Capacitance C_T (pF)	Maximum Forward Voltage V_F (mV)
5316	5317	Medium	4	12	0.25	500
5312	5313			16	0.15	
5310	5311			20	0.10	
5336	5337	Low	4	12	0.25	375
5332	5333			16	0.15	
5330	5331			20	0.10	
Test Conditions	$\Delta V_F \leq 15$ mV @ 5 mA		$I_R = 10\ \mu A$	I_F = 5 mA	V_R = 0V f = 1 MHz	I_F = 1 mA

*Minimum batch size 20 units.

Typical Detector Characteristics at $T_A = 25°C$

MEDIUM AND LOW BARRIER (DC BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-54	dBm	20μA Bias
Voltage Sensitivity	γ	6.6	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	Rv	1400	Ω	f = 10 GHz

LOW BARRIER (ZERO BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-44	dBm	Zero Bias
Voltage Sensitivity	γ	10	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	Rv	1.8	MΩ	f = 10 GHz

Typical Parameters

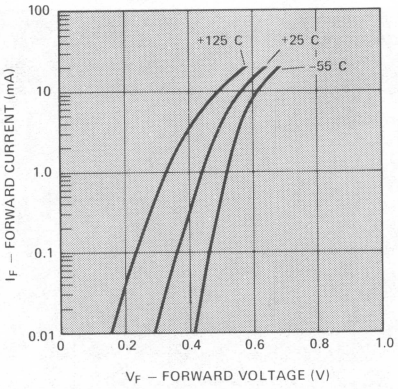


Figure 1. Typical Forward Characteristics, for Medium Barrier Beam Lead Diodes. HSCH-5310, -5320 Series.

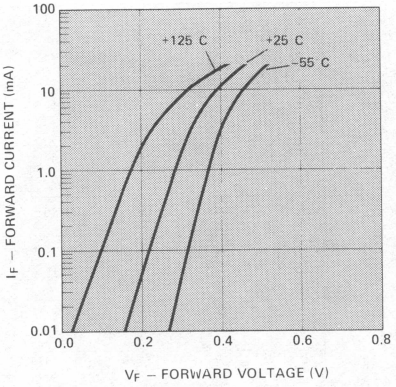


Figure 2. Typical Forward Characteristics, for Low Barrier Beam Lead Diodes. HSCH-5330, -5340 Series.

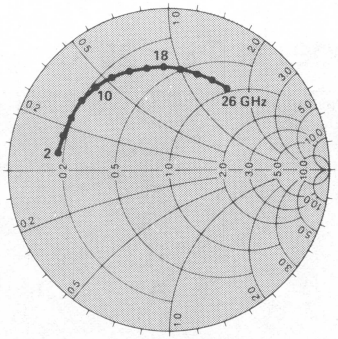


Figure 3. Typical Admittance Characteristics, with 1 mA Self Bias HSCH-5320, -5340, -5321, and -5341.

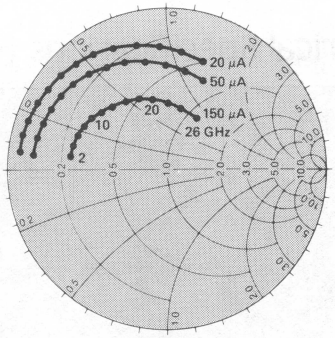


Figure 4. Typical Admittance Characteristics, with External Bias. HSCH-5320, -5340, -5321, and -5341.

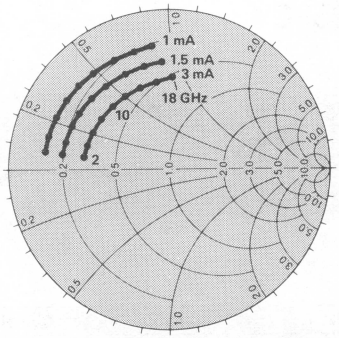


Figure 5. Typical Admittance Characteristics, with Self Bias. HSCH-5314, -5315, -5334, and -5335.

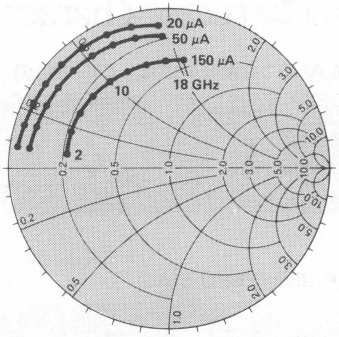


Figure 6. Typical Admittance Characteristics with External Bias. HSCH-5314, -5315, -5334, and -5335.

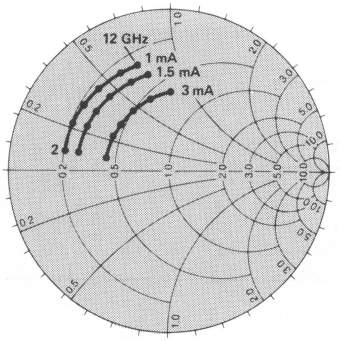


Figure 7. Typical Admittance Characteristics, with Self Bias HSCH-5318, -5319, -5338 and -5339.

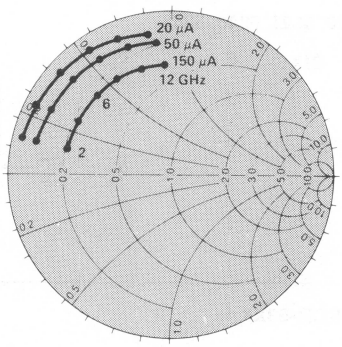


Figure 8. Typical Admittance Characteristics with External Bias. HSCH-5318, -5319, -5338 and -5339.

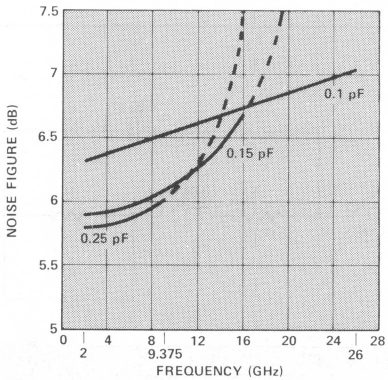
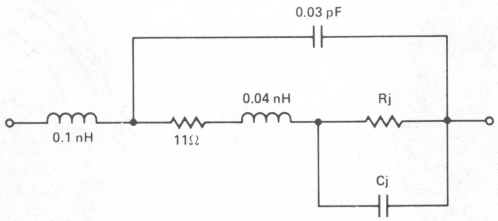


Figure 9. Typical Noise Figure vs. Frequency.

MODELS FOR EACH BEAM LEAD SCHOTTKY DIODE

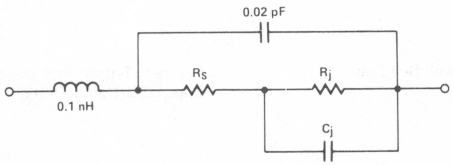
HSCH-5320, 5321, 5340, 5341

1 mA SELF BIAS



OTHER HSCH-53XX

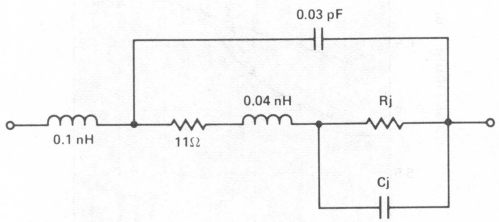
SELF BIAS



Part Numbers	1.0 mA Self Bias			1.5 mA Self Bias			3.0 mA Self Bias		
	R_S (Ω)	R_j (Ω)	C_j (pF)	R_S (Ω)	R_j (Ω)	C_j (pF)	R_S (Ω)	R_j (Ω)	C_j (pF)
HSCH-5314, -5315, -5334, -5335	5.0	393	0.11	5.2	232	0.11	5.0	150	0.12
HSCH-5318, -5319, -5338, -5339	5.1	244	0.16	5.0	178	0.16	5.0	109	0.19

HSCH-5320, -5321, -5340, -5341

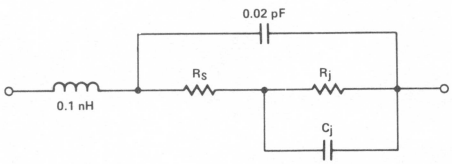
EXTERNAL BIAS



Part Numbers	20 μA DC Bias		50 μA DC Bias		150 μA DC Bias	
	R_j (Ω)	C_j (pF)	R_j (Ω)	C_j (pF)	R_j (Ω)	C_j (pF)
HSCH-5320, -5321, -5340, -5341	1400	0.09	560	0.09	187	0.10

OTHER HSCH-53XX

EXTERNAL BIAS



Part Numbers	20 μADC Bias			50 μADC Bias			150 μADC Bias		
	R_S (Ω)	R_j (Ω)	C_j (pF)	R_S (Ω)	R_j (Ω)	C_j (pF)	R_S (Ω)	R_j (Ω)	C_j (pF)
HSCH-5314, -5315, -5334, -5335	2.8	1240	0.11	4.7	618	0.12	2.7	211	0.13
HSCH-5318, -5319, -5338, -5339	5.1	2050	0.18	3.9	665	0.19	4.7	242	0.20

HEWLETT PACKARD

BEAM LEAD SCHOTTKY DIODE

5082-2837

Features

FAST SWITCHING

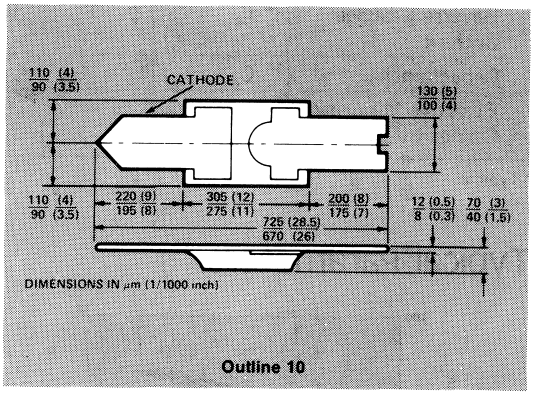
HIGH BREAKDOWN

BEAM LEAD EQUIVALENT OF 5082-2800

PLATINUM TRI-METAL SYSTEM

WIDE TEMPERATURE RANGE

SiO_2 PASSIVATION



Outline 10

Description

The HP 5082-2837 is an epitaxial planar passivated beam lead diode whose construction utilizes a unique combination of both a conventional PN junction and a Schottky barrier. This manufacturing process results in a device which has the high breakdown and temperature characteristics of silicon, the turn-on voltage of germanium and the speed of a Schottky diode majority carrier device.

This device is intended for high volume, low cost applications, and is the beam lead equivalent of the HP 5082-2800 glass packaged diode.

Maximum Ratings

Operating Temperature Range ..... −65° C to +175° C
Storage Temperature Range ..... −65° C to +200° C
Minimum Lead Strength .... 4 grams pull on either lead
Diode Mounting Temperature ... 350° C for 10 sec. max.

Applications

High level detection, switching, or gating; logarithmic or A-D converting; sampling or wave shaping are jobs the 5082-2837 will do better than conventional PN junction diodes. The low turn-on voltage and subnanosecond switching makes it extremely attractive in digital circuits for DTL gates, pulse shaping circuits or other low level applications. Its high PIV allows wide dynamic range for fast high voltage sampling gates.

The 5082-2837 low turn-on voltage gives low offsets. The extremely low stored charge minimizes output offsets caused by the charge flow in the storage capacitor. At UHF, the diodes exhibit 95% rectification efficiencies. Both their low loss and their high PIV allow the diodes to be used in mixer and modulator applications which require wide dynamic ranges.

The combination of these technical features with the low price make these devices the prime consideration for any hybrid DC or RF circuit requiring nonlinear elements.

Bonding and Handling Procedures

See page 4-36.

Electrical Specifications at T_A=25°C

Specification	Symbol	Min.	Max.	Units	Test Conditions
Breakdown Voltage	V_{BR}	70	–	Volts	I_R = 10μA
Forward Voltage	V_{F1}	–	410	mV	I_{F1} = 1mA
Forward Voltage	V_{F2}	–	1.0	V	I_{F2} = 15mA
Reverse Leakage Current	I_R	–	200	nA	V_R = 50V
Capacitance	C_o	–	2.0	pF	V_R = 0V and f= 1MHz
Effective Minority Carrier Lifetime	τ	–	100 *	pS	I_F = 5mA Krakauer Method

* Typical

Typical Parameters

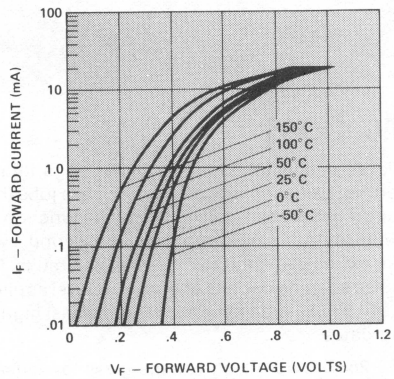


Figure 1. Typical Forward Characteristics

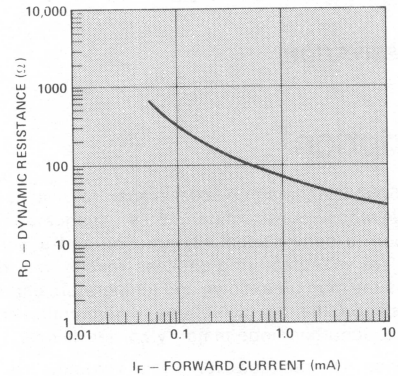


Figure 2. Typical Dynamic Resistance (R_D) vs. Forward Current (I_F)

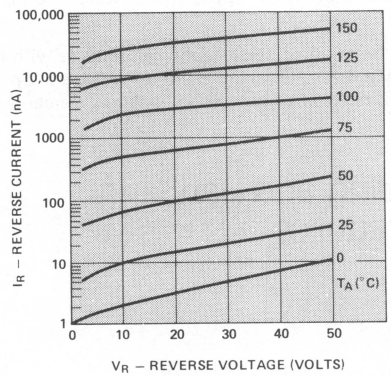


Figure 3. Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures

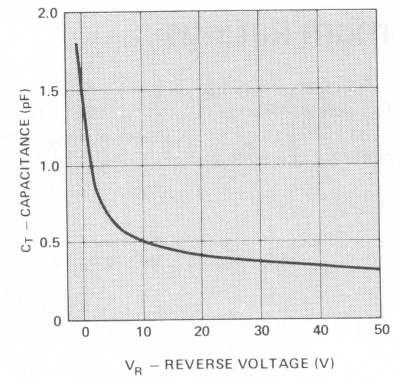


Figure 4. Typical Capacitance (C_T) vs. Reverse Voltage (V_R)

HEWLETT PACKARD

BEAM LEAD SCHOTTKY DIODE PAIRS FOR MIXERS AND DETECTORS

HSCH-5500 SERIES

Features

MONOLITHIC PAIR
Closely Matched Electrical Parameters

LOW CAPACITANCE
0.1 pF Maximum at 0 Volts

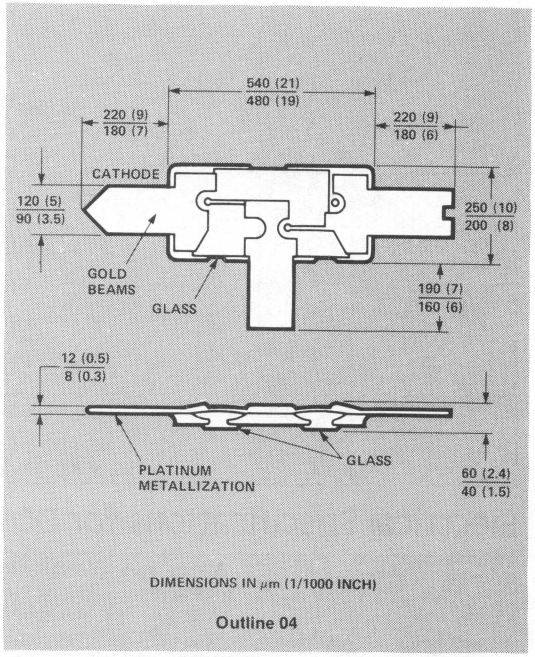
LOW NOISE FIGURE
Guaranteed 7.5 dB at 26 GHz

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

PLATINUM TRI-METAL SYSTEM
High Temperature Stability

POLYMIDE SCRATCH PROTECTION

SILICON NITRIDE PASSIVATION
Stable, Reliable Performance



Outline 04

Description

These dual beam lead diodes are constructed using a metal-semiconductor Schottky barrier junction. Advanced epitaxial techniques and precise process control insure uniformity and repeatability of this planar passivated microwave semiconductor. A nitride passivation layer provides immunity from contaminants which could otherwise lead to I_R drift.

The HP beam lead process allows for large beam anchor pads for rugged construction (typical 6 gram pull strength) without degrading capacitance.

Maximum Ratings (for Each Diode)

Pulse Power Incident at $T_A = 25°C$ ..... 1 W
Pulse Width = 1 μs, Du = 0.001
CW Power Dissipation at $T_A = 25°C$ ..... 150 mW
Measured in an infinite heat sink derated linearly to zero at maximum rated temperature.

T_{OPR} — Operating Temperature Range ..... −65°C to +175°C
T_{STG} — Storage Temperature Range ..... −65°C to +200°C
Minimum Lead Strength ..... 4 grams pull on any lead
Diode Mounting Temperature ..... 350°C for 10 sec. max.

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Applications

The beam lead diode is ideally suited for use in stripline or microstrip or coplanar waveguide circuits. Its small physical size and uniform dimensions give it low parasitics and repeatable RF characteristics through K-band.

These dual beam leads are intended for use in balanced mixers and in even harmonic anti-parallel pair mixers. By using several of these devices in the proper configuration it is easy to assemble bridge quads, star quads, and ring quads for Class I, II, or III type double balanced mixers.

Bonding and Handling Procedures

See page 4-36.

Electrical Specifications for RF tested Diodes at T_A =25° C

Part Number HSCH-	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	IF Impedance Z_{IF} (Ω) Max.	Maximum SWR	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Max. ΔR_D (Ω)	Maximum Total Capacitance C_T (pF)	Max. ΔC_T (pF)	Maximum Forward Voltage V_F (mV)	Max. ΔV_F (mV)
5520	Medium	7.5 at 26 GHz	200	400	1.5:1	4	20	3	0.10	0.02	500	10
5510		7.0 at 16 GHz					20		0.10			
5518		7.2 at 16 GHz					16	2	0.15	0.03		
5514		6.2 at 9.375 GHz					12		0.25			
5540	Low	7.5 at 26 GHz	150	350			20	3	0.10	0.02	375	
5530		7.0 at 16 GHz					20		0.10			
5538		7.2 at 16 GHz					16	2	0.15	0.03		
5534		6.2 at 9.375 GHz					12		0.25			
Test Conditions		DC Load Resistance = 0 Ω LO Power = 1 mW I_F = 30 MHz, 1.5 dB NF				I_R = 10 μA	I_F = 5 mA		V_R = 0 V f = 1 MHz		I_F = 1 mA	
						Measured across adjacent leads.						

Electrical Specifications for DC tested Diodes at T_A =25° C

Part Number HSCH-	Barrier	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Max. ΔR_D (Ω)	Maximum Total Capacitance C_T (pF)	Max. ΔC_T (pF)	Maximum Forward Voltage V_F (mV)	Max. ΔV_F (mV)
5511	Medium	4	20	3	0.10	0.02	500	10
5512			16	2	0.15	0.03		
5516			12		0.25			
5531	Low		20	3	0.10	0.02	375	
5532			16	2	0.15	0.03		
5536			12		0.25			
Test Conditions		I_R = 10 μA	I_F = 5 mA		V_R = 0 V f = 1 MHz		I_F = 1 mA	

Typical Detector Characteristics at T_A =25° C

MEDIUM BARRIER AND LOW BARRIER (DC BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-55	dBm	20μA Bias
Voltage Sensitivity	γ	9.0	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	R_V	1350	Ω	f = 10 GHz

LOW BARRIER (ZERO BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-46	dBm	Zero Bias
Voltage Sensitivity	γ	17	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	R_V	1.4	MΩ	f = 10 GHz

Typical Parameters

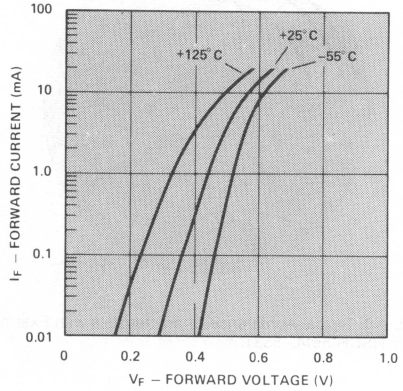


Figure 1. Typical Forward Characteristics, for Medium Barrier Beam Lead Diodes. HSCH-5520 and HSCH-551X Series.

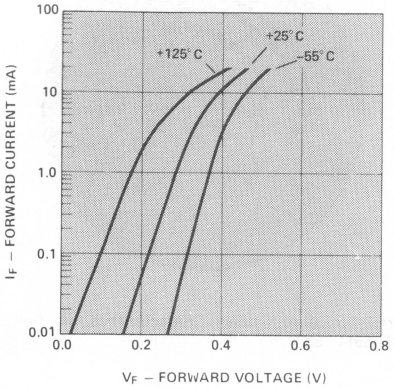


Figure 2. Typical Forward Characteristics for Low Barrier Beam Lead Diodes. HSCH-5540 and HSCH-553X Series.

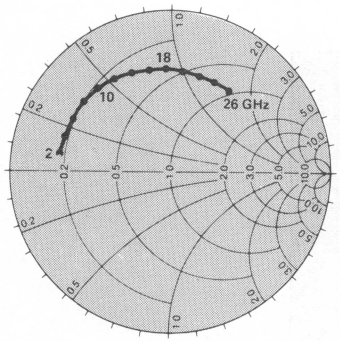


Figure 3. Typical Admittance Characteristics with 1 mA Self Bias HSCH-5510, -5520, -5530, and -5340.

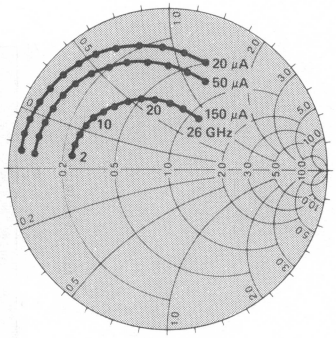


Figure 4. Typical Admittance Characteristics with External Bias. HSCH-5510, -5520, -5530, and -5540.

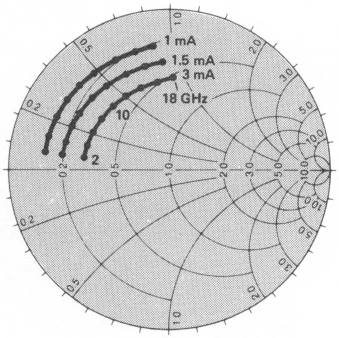


Figure 5. Typical Admittance Characteristics with Self Bias. HSCH-5518, -5538.

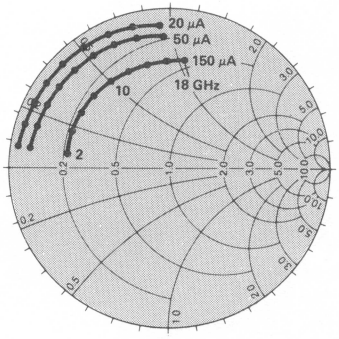


Figure 6. Typical Admittance Characteristics with External Bias. HSCH-5518, -5538.

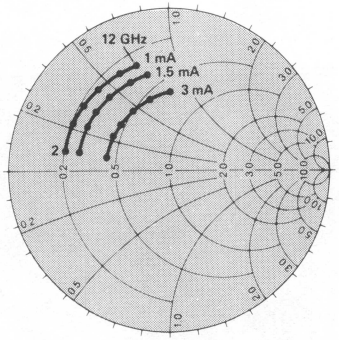


Figure 7. Typical Admittance Characteristics, with Self Bias. HSCH-5514, -5534.

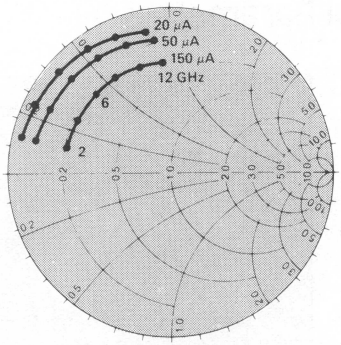


Figure 8. Typical Admittance Characteristics with External Bias. HSCH-5514, -5534.

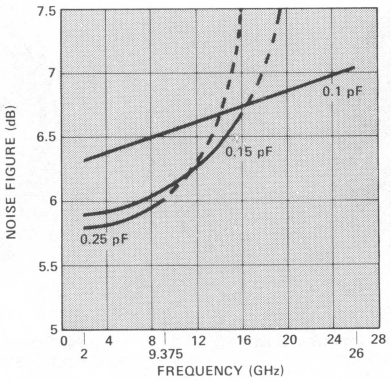
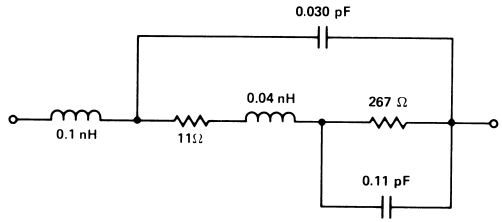


Figure 9. Typical Noise Figure vs. Frequency.

Models for Each Beam Lead Schottky Diode

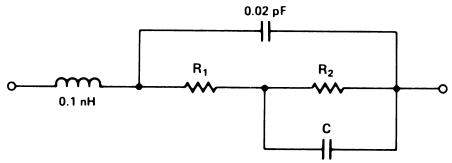
HSCH-5510, -5520, -5530, -5540

1 mA SELF BIAS



HSCH-5514, -5518, -5534, -5538

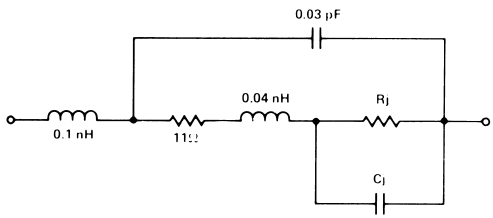
SELF BIAS



Part Numbers	1.0 mA Self Bias			1.5 mA Self Bias			3.0 mA Self Bias		
	R_1 (Ω)	R_2 (Ω)	C (pF)	R_1 (Ω)	R_2 (Ω)	C (pF)	R_1 (Ω)	R_2 (Ω)	C (pF)
HSCH-5518, -5538	5.0	393	0.11	5.2	232	0.11	5.0	150	0.12
HSCH-5514, -5534	5.1	244	0.16	5.0	178	0.16	5.0	109	0.19

HSCH-5510, -5520, -5530, -5540

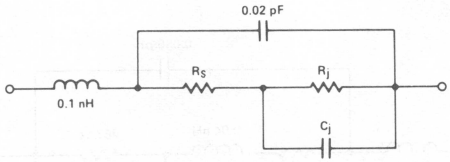
EXTERNAL BIAS



Part Numbers	20 μA DC Bias		50 μA DC Bias		150 μA DC Bias	
	R_j (Ω)	C_j (pF)	R_j (Ω)	C_j (pF)	R_j (Ω)	C_j (pF)
HSCH-5510, -5520, -5530, -5540	1400	0.09	560	0.09	187	0.10

HSCH-5518, -5538, -5514, -5534

EXTERNAL BIAS



Part Numbers	20 μA DC Bias			50 μA DC Bias			150 μA DC Bias		
	R_S	R_j (Ω)	C_j (pF)	R_S (Ω)	R_j (Ω)	C_j (pF)	R_S (Ω)	R_j (Ω)	C_j (pF)
HSCH-5518, -5538	2.8	1240	0.11	4.7	618	0.12	2.7	211	0.13
HSCH-5514, -5534	5.1	2050	0.18	3.9	665	0.19	4.7	242	0.20

HEWLETT PACKARD

BEAM LEAD SCHOTTKY DIODE QUADS FOR DOUBLE BALANCED MIXERS OPERATING TO 26 GHz

HSCH-5800 SERIES

Features

MONOLITHIC RING QUADS
Closely Matched Electrical Parameters

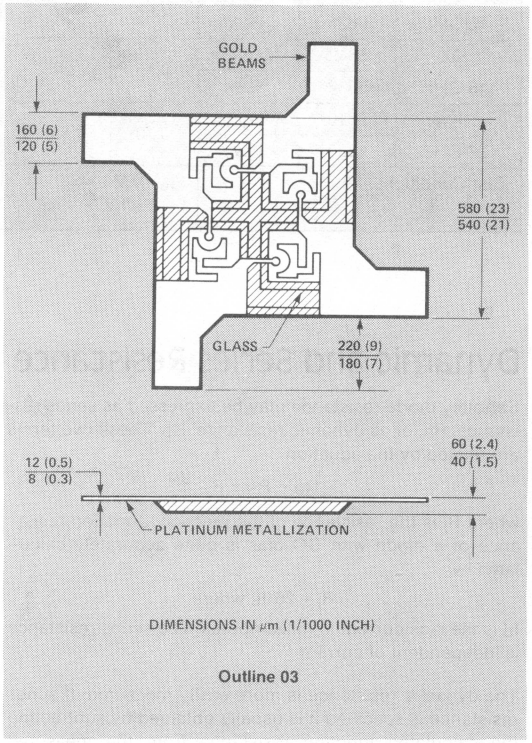
LOW CAPACITANCE
0.10 pF Max. at 0 V

PLANAR SURFACE
Easier Bonding, Stronger Leads

PLATINUM TRI-METAL SYSTEM
High Temperature Stability

POLYIMIDE SCRATCH PROTECTION

SILICON NITRIDE PASSIVATION
Stable, Reliable Performance



Outline 03

Description

These beam lead diode quads are constructed using a metal-semiconductor Schottky barrier junction. Advanced epitaxial techniques and precise process control insure uniformity and repeatability of this planar passivated microwave semiconductor. A nitride passivation layer provides immunity from contaminants which could otherwise lead to I_R drift.

Maximum Ratings

CW Power Dissipation at T_{LEAD} = 25°C ..... 150 mW
Derate linearly to zero at maximum rated temperature.

T_{OPR} — Operating Temperature Range ..... −65°C to +175°C

T_{STG} = Storage Temperature Range ..... −65°C to +200°C

Minimum Lead Strength ..... 4 grams pull on any lead

Diode Mounting Temperature ..... 350°C for 10 sec. max.

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Applications

These diodes are designed for use in double balanced mixers, phase detectors, AM modulator, and digital modulators requiring wideband operation and small size. The outline geometries are designed to balance the internal lead inductance for optimal performance at higher frequencies. The monolithic construction results in inherently low parasitics and extremely tight uniformity. The low barrier diodes allow for optimum mixer noise figure at lower than conventional local oscillator level. The wider dynamic range of the medium barrier diodes allows for better distortion performance.

Bonding and Handling Procedures

See page 4-36.

Electrical Specifications at $T_A = 25°C$

Frequency Band	Part Number HSCH-	Barrier	Maximum Capacitance C_T (pF)		Maximum Adjacent Capacitance Difference ΔC_T (pF)	Maximum Dynamic Resistance R_D (Ω)	Maximum Resistance Difference ΔR_D (Ω)	Maximum Forward Voltage V_F (mV)	Maximum V_F Difference ΔV_F (mV)
			Diagonal	Adjacent					
X	5816	Medium	0.25	0.33	0.03	12	2	500	15
12 GHz	5836	Low						375	
Ku	5812	Medium	0.15	0.20		16		500	
18 GHz	5832	Low						375	
K	5810	Medium	0.10	0.13	0.02	20	3	500	
26 GHz	5830	Low						375	
Test Conditions			$V_R = 0$ V, f = 1 MHz			$I_F = 5$ mA		$I_F = 1$ mA, Measured between adjacent leads	

Dynamic and Series Resistance

Schottky diode resistance may be expressed as series resistance, R_S, or as dynamic resistance, R_D. These two terms are related by the equation

$$R_D = R_S + R_j$$

where R_j is the resistance of the junction. Junction resistance of a diode with DC bias is quite accurately calculated by

$$R_j = 26/I_B \text{ where}$$

I_B is the bias current in milliamperes. The series resistance is independent of current.

The dynamic resistance is more easily measured. If series resistance is specified it is usually obtained by subtracting the calculated junction resistance from the measured dynamic resistance.

Diagonal and Adjacent Capacitance

In a ring quad, diagonal capacitance is the capacitance tested between points A and B as shown in Figure 1. The diagonal capacitance measurement has the same value as the individual diode in the quad.

Example:

$$C_{DIAGONAL} = \frac{C_1 \times C_2}{C_1 + C_2} + \frac{C_3 \times C_4}{C_3 + C_4}$$

Assuming $C_1 = C_2 = C_3 = C_4 = 1.0$ pF

$C_{DIAGONAL} = 1/2 + 1/2 = 1.0$ pF

The capacitance value of the individual diode measured between points A and C in Figure 1 is the adjacent capacitance. The adjacent capacitance measurement of the individual diode contains some capacitive elements of the other diodes in the ring quad.

Example:

$$C_{ADJACENT} = C_1 + \frac{1}{\frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4}}$$

Assuming $C_1 = C_2 = C_3 = C_4 = 1.0$ pF

$C_{ADJACENT} = 1 + 1/3 = 1.333$ pF

Therefore, the adjacent capacitance value of the individual diode in the Schottky ring quad is 33% higher than the actual (diagonal) capacitance value, i.e. $C_{ADJACENT} \cong 1.333 \times C_{DIAGONAL}$.

Hewlett-Packard guarantees maximum adjacent capacitance through 100% testing to the limits shown on the data sheet. Maximum diagonal capacitance values have been calculated.

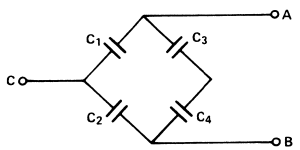


Figure 1.

Typical Characteristics

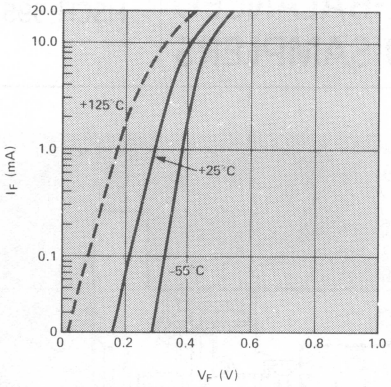


Figure 2. Typical Forward Characteristics for Low Barrier Diodes. HSCH-583X Series.

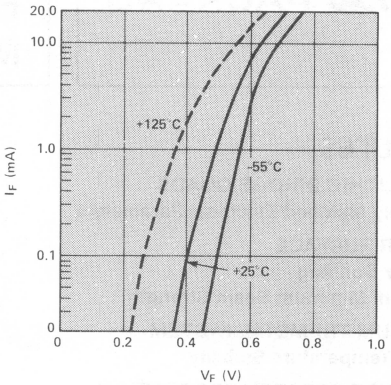


Figure 3. Typical Forward Characteristics for Medium Barrier Diodes. HSCH-581X Series.

HEWLETT PACKARD

BEAM LEAD SCHOTTKY DIODE BRIDGE QUADS FOR DOUBLE-BALANCED MIXERS AND SAMPLERS

HSCH-5918
HSCH-5938
HSCH-5958

Features

MONOLITHIC BRIDGE QUADS
Closely Matched Electrical Parameters

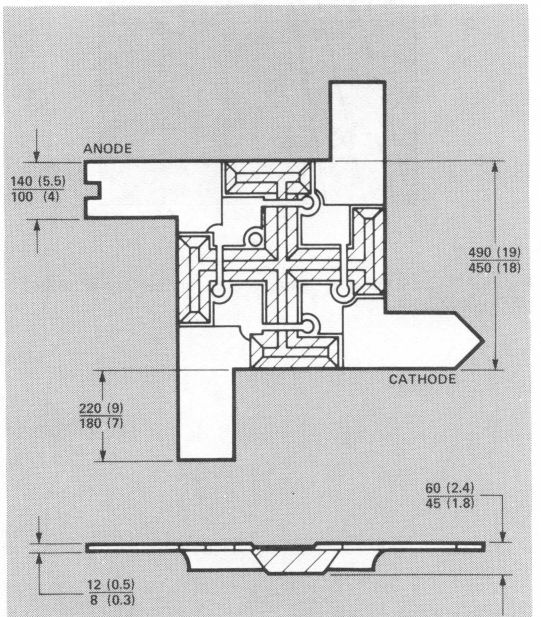
PLANAR SURFACE
Easier Bonding
8 Gram Minimum Beam Strength

PLATINUM TRI-METAL SYSTEM
High Temperature Stability

POLYIMIDE SCRATCH PROTECTION

SILICON NITRIDE PASSIVATION
Stable, Reliable Performance

Available July '87



DIMENSIONS IN MILLIMETERS (INCHES).

Outline

Description/Applications

These beam lead diode quads are constructed using a metal-semiconductor Schottky barrier junction. Advanced epitaxial techniques and precise process control ensure uniformity and repeatability of this planar passivated microwave semiconductor. A nitride passivation layer provides immunity from contaminants which could otherwise lead to I_R drift.

These diodes are designed for use in doubly balanced mixers, and sampling circuits requiring wideband operation and small size. The monolithic construction results in inherently low parasitics and extremely tight uniformity. The wide dynamic range of medium barrier diodes allows for good distortion performance.

Maximum Ratings

Operating Temperature . . . . . -65°C to +175°C
Storage Temperature . . . . . -65°C to +200°C
Diode Mounting Temperature . . . . . 350°C for 10 sec. max.

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Assembly Techniques

Thermocompression bonding is recommended. Welding, ultrasonic bonding, solder, or conductive epoxy may also be used. For additional information see Application Note 979, "The Handling and Bonding of Beam Lead Devices Made Easy", or Application Note 992, "Beam Lead Attachment Methods", or Application Note 993, "Beam Lead Device Bonding to Soft Substrates".

Bonding and Handling Procedures

See page 4-36.

Electrical Specifications at $T_A = 25°C$

Part Number	Barrier	Maximum Capacitance C_T (pF)*		Maximum Adjacent Capacitance Difference ΔC_T (pF)	Maximum Dynamic Resistance R_D (Ω)	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	Maximum V_F Difference ΔV_F (mV)
		Diag.	Adj.					
HSCH-5938 HSCH-5918 HSCH-5958	Low Medium High	0.50	0.67	0.50	12	5	350 450 650	20
Test Conditions		$V_R = 0$ V	f = 1 MHz	$V_R = 0$ V f = 1 MHz	$I_F = 5$ mA	$I_R \leq 10\,\mu$A	$I_F = 1$ mA	$I_F = 5$ mA
				Measured across adjacent leads				

*Lower capacitance values are also available.

Dynamic and Series Resistance

Schottky diode resistance may be expressed as series resistance, R_S, or as dynamic resistance, R_D. These two terms are related by the equation

$$R_D = R_S + R_j$$

where R_j is the resistance of the junction. Junction resistance of a diode with DC bias is quite accurately calculated by

$$R_j = 26/I_B \text{ where}$$

I_B is the bias current in milliamperes. The series resistance is independent of current.

The dynamic resistance is more easily measured. If series resistance is specified, it is usually obtained by subtracting the calculated junction resistance from the measured dynamic resistance.

Diagonal and Adjacent Capacitance

In a ring quad, diagonal capacitance is the capacitance tested between points A and B as shown in Figure 1. The diagonal capacitance measurement has the same value as the individual diode in the quad.

Example:

$$C_{DIAGONAL} = \frac{C_1 \times C_2}{C_1 + C_2} + \frac{C_3 \times C_4}{C_3 + C_4}$$

Assuming $C_1 = C_2 = C_3 = C_4 = 1.0$ pF

$C_{DIAGONAL} = 1/2 + 1/2 = 1.0$ pF

The capacitance value of the individual diode measured across points A and C in Figure 1 is the adjacent capacitance. The adjacent capacitance measurement of the individual diode contains some capacitive elements of the other diodes in the ring quad.

Example:

$$C_{ADJACENT} = C_1 + \frac{1}{\frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4}}$$

Assuming $C_1 = C_2 = C_3 = C_4 = 1.0$ pF

$C_{ADJACENT} = 1 + 1/3 = 1.333$ pF

Therefore, the adjacent capacitance value of the individual diode in the Schottky ring quad is 33% higher than the actual (diagonal) capacitance value, i.e. $C_{ADJACENT} \cong 1.333 \times C_{DIAGONAL}$.

Hewlett-Packard guarantees maximum adjacent capacitance through 100% testing to the limits shown on the data sheet. Maximum diagonal capacitance values have been calculated.

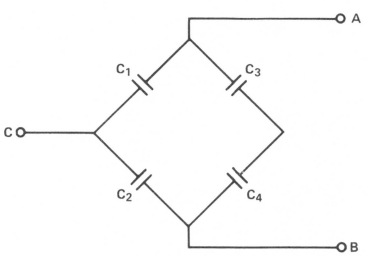


Figure 1.

Bonding and Handling Procedures for Beam Lead Diodes

1. Storage

Under normal circumstances, storage of beam lead diodes in HP supplied waffle/gel packs is sufficient. In particularly dusty or chemically hazardous environments, storage in an inert atmosphere desiccator is advised.

2. Handling

In order to avoid damage to beam lead devices, particular care must be exercised during inspection, testing, and assembly. Although the beam lead diode is designed to have exceptional lead strength, its small size and delicate nature requires that special handling techniques be observed so that the devices will not be mechanically or electrically damaged. A vacuum pickup is recommended for picking up beam lead devices, particularly larger ones, e.g., quads. Care must be exercised to assure that the vacuum opening of the needle is sufficiently small to avoid passage of the device through the opening. A #27 tip is recommended for picking up single beam lead devices. A 20X magnification is needed for precise positioning of the tip on the device. Where a vacuum pickup is not used, a sharpened wooden Q-tip dipped in isopropyl alcohol is very commonly used to handle beam lead devices.

3. Cleaning

For organic contamination use a warm rinse of trichloroethane followed by a cold rinse in acetone and methanol. Dry under infrared heat lamp for 5–10 minutes on clean filter paper. Freon degreaser may replace trichloroethane for light organic contamination.

- Ultrasonic cleaning is not recommended
- Acid solvents should not be used

4. Bonding

See Application Note 992, "Beam Lead Attachment Methods", for a general description of the various methods for attaching beam lead diodes to both hard and soft substrates.

Thermocompression: See Application Note 979 "The Handling and Bonding of Beam Lead Devices Made Easy". This method is good for hard substrates only.

Wobble: This method picks up the device, places it on the substrate and forms a thermocompression bond all in one operation. This is described in MIL-STD-883, Method 2017 and is intended for hard substrates only. Equipment specifically designed for beam lead wobble bonding is available from KULICKE and SOFFA in Horsham, PA.

Ultrasonic: Not recommended.

Resistance Welding or Parallel-GAP Welding: To make welding quads easier, attach one electrode of the welder to the substrate and use the second electrode for welding in lieu of the parallel gap electrode. To make welding on soft substrates easier, a low pressure welding head is recommended. Suitable equipment is available from HUGHES, Industrial Products Division in Carlsbad, CA.

For more information, see Application Note 993, "Beam Lead Diode Bonding to Soft Substrates".

Epoxy: With solvent free, low resistivity epoxies (available from ABLESTIK in Gardenia, CA, MICON in Lexington, MA, and many others) and improvements in dispensing equipment, the quality of epoxy bonds is sufficient for many applications. Equipment is available from ADVANCED SEMICONDUCTOR MATERIALS AMERICA, INC., Assembly Products Group in Chandler, AZ (Automatic), and West Bond in Orange, CA (Manual).

Reflow: By preparing the substrate with tin or solder plating, reflow soldering can be suitably performed using a modified wire bonder. The probe is used as a soldering tip. WEST BOND or UNITEK bonders make suitable bonds.

HEWLETT PACKARD

SURFACE MOUNT SCHOTTKY BARRIER DIODES FOR GENERAL PURPOSE APPLICATIONS

NEW

HSMS-280X Series
HSMS-281X Series
HSMS-282X Series
HSMS-284X Series

Features

SURFACE MOUNT PACKAGE

LOW TURN-ON VOLTAGE
As Low As 0.34 V at 1 mA

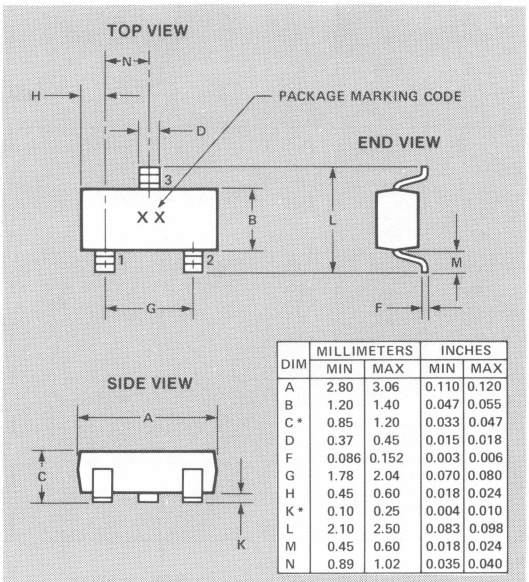
RELIABILITY
— Silicon Nitride Passivation
— Gold Metallized Chip

HIGH BREAKDOWN VOLTAGE
Up to 70 V

PICO SECOND SWITCHING SPEED

DUAL VERSIONS AVAILABLE
(Matched Diodes)

LOW COST



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.06	0.110	0.120
B	1.20	1.40	0.047	0.055
C *	0.85	1.20	0.033	0.047
D	0.37	0.45	0.015	0.018
F	0.086	0.152	0.003	0.006
G	1.78	2.04	0.070	0.080
H	0.45	0.60	0.018	0.024
K *	0.10	0.25	0.004	0.010
L	2.10	2.50	0.083	0.098
M	0.45	0.60	0.018	0.024
N	0.89	1.02	0.035	0.040

Outline 23

NOTE: MEETS ALL JEDEC DIMENSIONAL REQUIREMENTS FOR TO-236AA/AB*

*LOW PROFILE Option:
with C min/max of 0.89/1.04 millimeters, 0.035/0.041 inches;
with K min/max of 0.013/0.10 millimeters, 0.0005/0.004 inches.

Description/Applications

These Schottky diodes are specifically designed for analog and digital applications requiring devices in the SOT-23 surface mount package. This series offers a wide range of specifications and package configurations to give the designer wide flexibility. Typical applications of these Schottky diodes are mixing, detecting, switching, gating, sampling, and wave shaping.

Maximum Ratings

Junction Operating and Storage Temperature Range ..... -65° C to +125° C

DC Power Dissipation (for each diode) ..... 250 mW
(Measured in an infinite heat sink at T_{CASE} = 25° C). Derate linearly to zero at 125° C.

Peak Inverse Voltage (P_{IV}) ..... See V_{BR}

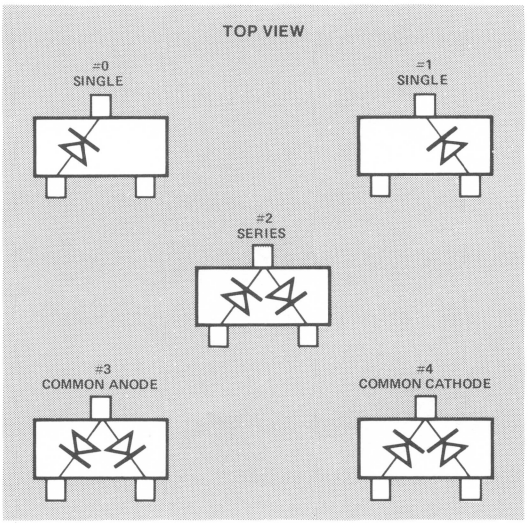
Forward Current (I_F) (1 μs pulse) ..... 1 Amp

Operation in excess of any one of these conditions may result in permanent damage to this device.

Package Characteristics

Lead Material ..... Alloy 42
Lead Finish ..... Tin-Lead, 95-5%
Max. Soldering Temperature ..... 260° C for 5 sec
Min. Lead Strength ..... 2 pounds pull
Typical Package Inductance ..... 2 nH
Typical Package Capacitance .... 0.08 pF (opposite leads)

Package Lead Code Identification



Electrical Specifications T_A = 25° C Single Diode

Part Number HSMS-	Package Marking Code[3]	Lead Code	Nearest Equivalent Offset Junction Chip Part No. HSMS-	Nearest Equivalent Axial Lead Part No. 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	Maximum Forward Voltage V_F (V) @ I_F (mA)	Maximum Reverse Leakage I_R (nA) @ V_R (V)	Maximum Capacitance C_T (pF)	Typical Dynamic Resistance R_D (Ω)
2800 2801 2802 2803 2804	A0 A1 A2 A3 A4	0 1 2 3 4	0001	2800 (1N5711)	70	410	1.0 15	200 50	2.0	35
2810 2811 2812 2813 2814	B0 B1 B2 B3 B4	0 1 2 3 4	0002	2810 (1N5712)	20	410	1.0 35	200 15	1.2	15
2820 2821 2822 2823 2824	C0 C1 C2 C3 C4	0 1 2 3 4	0003	2835	8*	340	0.5 10	100 1	1.0	10
2840 2841	J0 J1	0 1		HSCH-1001 (1N6263)	50 (See page 000 in "Switching Diodes" section for additional characterization.)	410	1.2 10	200 40	2.2	
Test Conditions					I_R = 10μA *I_R = 100μA	I_F = 1 mA[1]			V_R = 0 V f = 1.0 MHz[2]	I_F = 5 mA

Notes:

a. Effective Carrier Lifetime (τ) for all these diodes is 100 ps maximum measured with Krakauer method at 5 mA, except HSMS-282X which is measured at 20 mA.

b. Batch Matching available upon request.

1. ΔV_F for diodes in pairs is 15 mV maximum at 1 mA.
2. ΔC_{TO} for diodes in pairs is 0.2 pF maximum.
3. Package marking code is in white for standard profile. Package marking code is in orange for low profile.

Typical Parameters at $T_A = 25°C$ (unless otherwise noted)
Single Diode

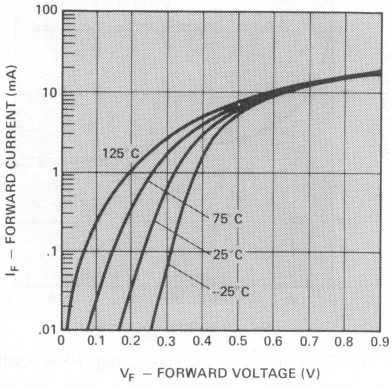


Figure 1. Forward Current vs. Forward Voltage @ Temperatures — HSMS-2800 Series

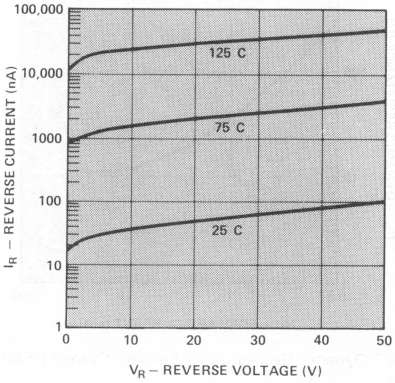


Figure 2. Reverse Current vs. Reverse Voltage @ Temperatures — HSMS-2800 Series

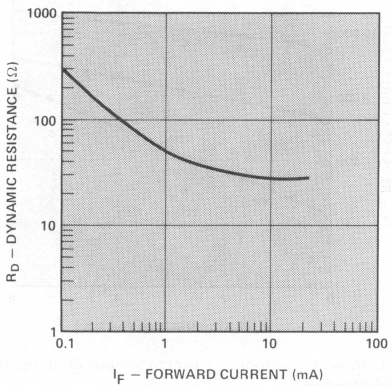


Figure 3. Dynamic Resistance vs. Forward Current HSMS-2800 Series

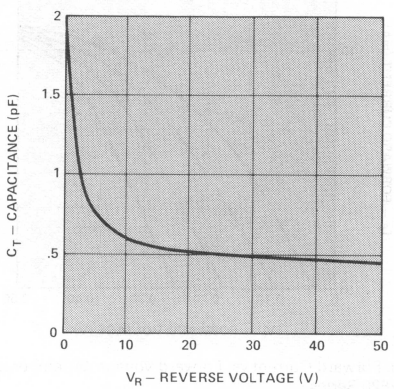


Figure 4. Total Capacitance vs. Reverse Voltage HSMS-2800 Series

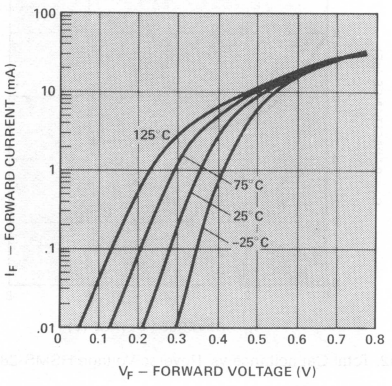


Figure 5. Forward Current vs. Forward Voltage @ Temperatures — HSMS-2810 Series

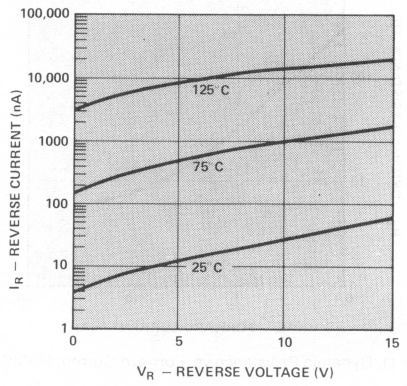


Figure 6. Reverse Current vs. Reverse Voltage @ Temperatures — HSMS-2810 Series

Typical Parameters (continued)

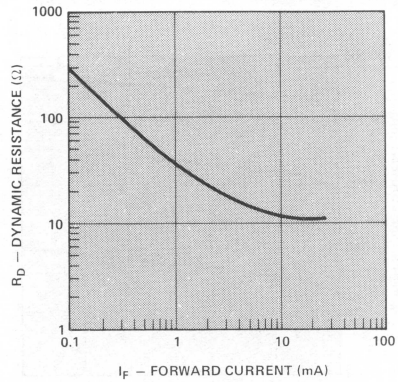


Figure 7. Dynamic Resistance vs. Forward Current HSMS-2810 Series

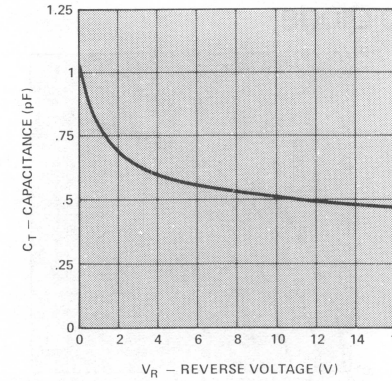


Figure 8. Total Capacitance vs. Reverse Voltage HSMS-2810 Series

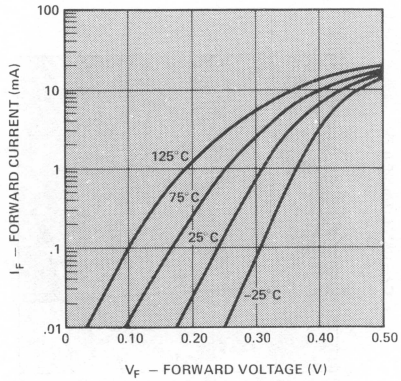


Figure 9. Forward Current vs. Forward Voltage @ Temperatures — HSMS-2820 Series

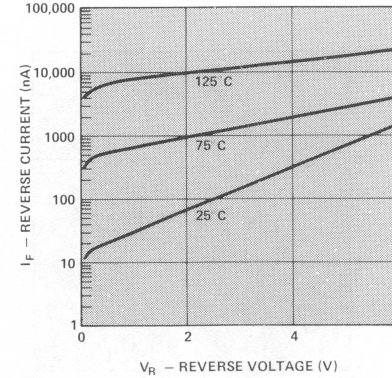


Figure 10. Reverse Current vs. Reverse Voltage @ Temperatures — HSMS-2820 Series

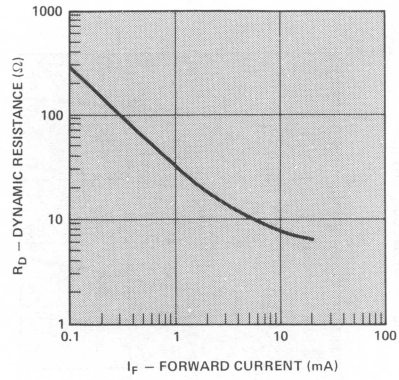


Figure 11. Dynamic Resistance vs. Forward Current HSMS-2820 Series

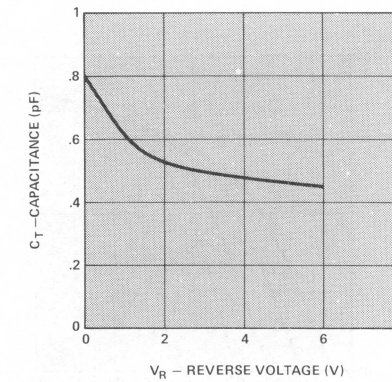


Figure 12. Total Capacitance vs. Reverse Voltage HSMS-2820 Series

Ordering Information

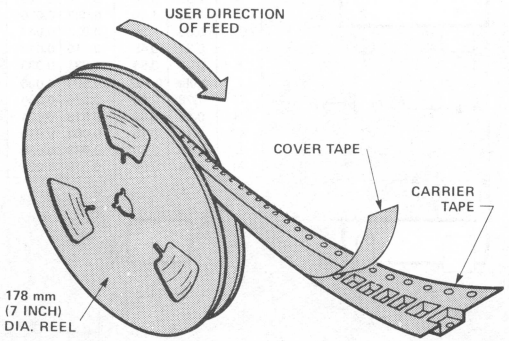
STANDARD PROFILE (WHITE MARKING)

Option T30 = Bulk
Option T31 = Tape and Reel, See Figure 1
Option T32 = Tape and Reel, See Figure 2

LOW PROFILE (ORANGE MARKING)

Option L30 = Bulk
Option L31 = Tape and Reel, See Figure 1
Option L32 = Tape and Reel, See Figure 2

Conforms to Electronic Industries Standard RS-481 "Taping of Surface Mounted Components for Automated Placement." Standard Quantity is 3,000 Devices/Reel.



Please refer to the "Tape and Reel Packaging for Surface Mount Devices" data sheet, publication number 5954-2077, catalog page number 4-127, for more detailed information on tape and reel dimensions.

Specify: Part Number followed by Option Number.
Example:

HSMS-28XX Option X XX

- XX — Bulk or Tape and Reel Option
- X — Profile: Standard = T, Low = L
- 28XX — Part Number
- HSMS — Surface Mount Schottky
- HSMS- — HP Standard Part

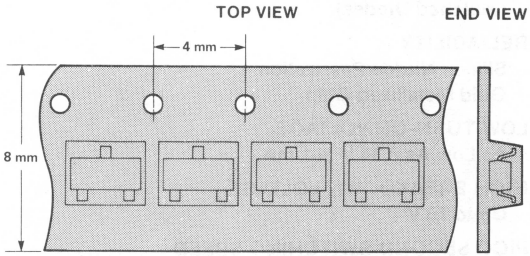


Figure 1. Options T31, L31

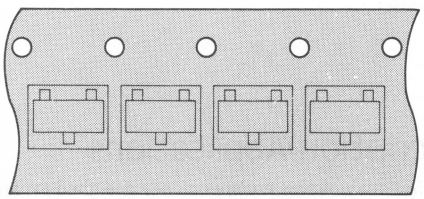


Figure 2. Options T32, L32

HEWLETT PACKARD

SURFACE MOUNT SCHOTTKY BARRIER DIODES FOR GENERAL PURPOSE APPLICATIONS

HSMS-2805
HSMS-2808
HSMS-2818
HSMS-2825
HSMS-2828

Features

SURFACE MOUNT SOT-143 PACKAGE

DUAL AND BRIDGE CONFIGURATIONS
(Matched Diodes)

RELIABILITY
Silicon Nitride Passivation
Gold Metallized Chip

LOW TURN-ON VOLTAGE
As Low As 0.34 V at 1 mA

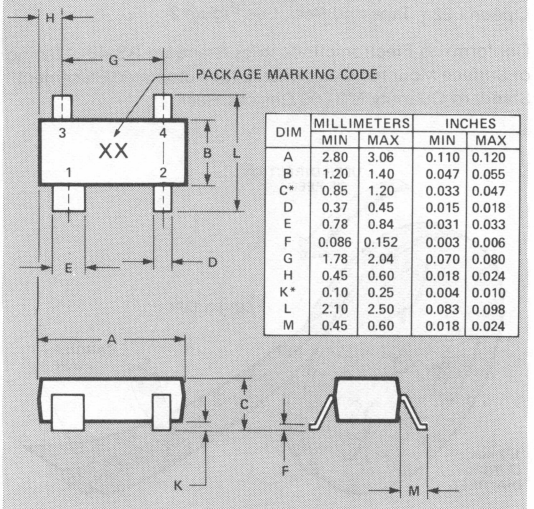
HIGH BREAKDOWN VOLTAGE
Up to 70 V

PICO SECOND SWITCHING SPEED

STANDARD AND LOW PROFILE

LOW COST

Standard Profile



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.06	0.110	0.120
B	1.20	1.40	0.047	0.055
C*	0.85	1.20	0.033	0.047
D	0.37	0.45	0.015	0.018
E	0.78	0.84	0.031	0.033
F	0.086	0.152	0.003	0.006
G	1.78	2.04	0.070	0.080
H	0.45	0.60	0.018	0.024
K*	0.10	0.25	0.004	0.010
L	2.10	2.50	0.083	0.098
M	0.45	0.60	0.018	0.024

*LOW PROFILE Option:
with C min/max of 0.89/1.04 millimeters, 0.035/0.041 inches;
with K min/max of 0.013/0.10 millimeters, 0.0005/0.004 inches.

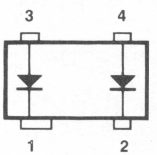
Outline 143

Description/Applications

These Schottky diodes are specifically designed for analog and digital applications requiring devices in the SOT-143 surface mount package. This series offers a wide range of specifications and package configurations to give the designer wide flexibility. Typical applications of these Schottky diodes are mixing, detecting, switching, gating, sampling, and wave shaping.

Package Lead Code Identification

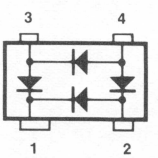
UNCONNECTED PAIR



Top View

Configuration #5

BRIDGE QUAD



Top View

Configuration #8

Maximum Ratings

Junction Operating and Storage Temperature Range ..... -65° C to +125° C

DC Power Dissipation (for each diode) ..... 250 mW
(Measured in an infinite heat sink at T_{CASE} = 25° C). Derate linearly to zero at 125° C.

Peak Inverse Voltage (P_{IV}) ..... Same as V_{BR}

Forward Current (I_F) (1 μs pulse) ..... 1 Amp

Operation in excess of any one of these conditions may result in permanent damage to this device.

Package Characteristics

Lead Material ..... Alloy 42
Lead Finish ..... Tin-Lead, 95-5%
Max. Soldering Temperature ..... 260° C for 5 sec
Min. Lead Strength ..... 2 pounds pull
Typical Package Inductance ..... 2 nH
Typical Package Capacitance ..... 0.08 pF

Electrical Specifications T_A = 25°C Single Diode

Part Number HSMS-	Package Marking Code[3]	Lead Code	Nearest Equivalent Offset Junction Chip Part No. HSMS-	Nearest Equivalent Axial Lead Part No. 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	Maximum Forward Voltage V_F (V) @ I_F (mA)	Maximum Reverse Leakage I_R (nA) @ V_R (V)	Maximum Capacitance C_T (pF)	Typical Dynamic Resistance R_D (Ω)
2805 2808	A5 A8	5 8	0001	2800 (1N5711)	70	410	1.0 15	200 50	2.0	35
2818	B8	8	0002	2810 (1N5712)	20	410	1.0 35	200 15	1.2	15
2825 2828	C5 C8	5 8	0003	2835	8*	340	0.5 10	100 1	1.0	10
Test Conditions					I_R = 10 μA *I_R = 100μA	I_F = 1 mA (1)			V_R = 0 V f = 1.0 MHz (2)	I_F = 5 mA

Notes:

A. Effective Carrier Lifetime (τ) for all these diodes is 100 ps maximum measured with Krakauer method at 5 mA, except HSMS-282X which is measured at 20 mA.

B. Batch Matching available upon request.

(1) ΔV_F for diodes in pairs and quads is 1.5 mV maximum at 1 mA.

(2) ΔC_T for diodes in pairs and quads is 0.2 pF maximum.

(3) Package marking code is white for standard profile.
Package marking code is orange for low profile.

Typical Parameters at $T_A = 25°C$ (unless otherwise noted)
Single Diode

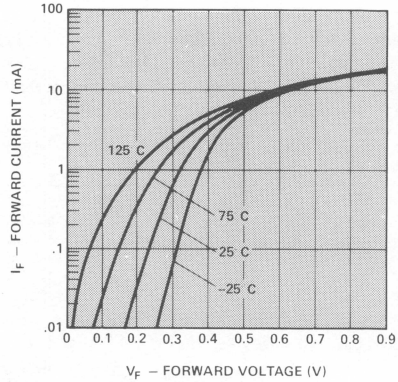


Figure 1. Forward Current vs. Forward Voltage @ Temperatures — HSMS-2800 Series

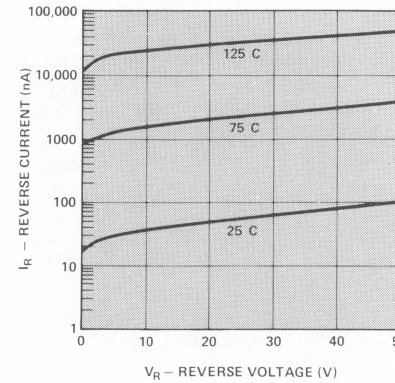


Figure 2. Reverse Current vs. Reverse Voltage @ Temperatures — HSMS-2800 Series

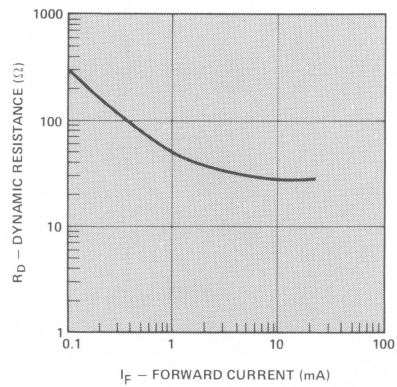


Figure 3. Dynamic Resistance vs. Forward Current HSMS-2800 Series

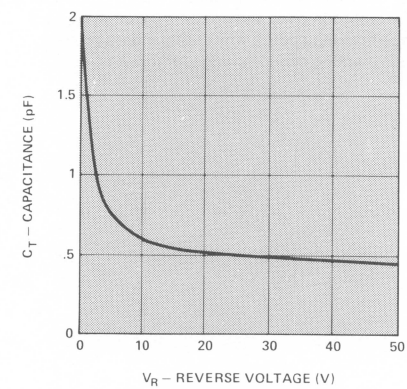


Figure 4. Total Capacitance vs. Reverse Voltage HSMS-2800 Series

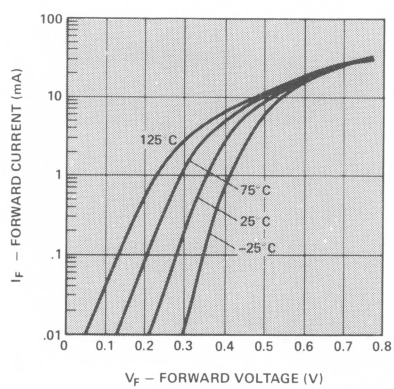


Figure 5. Forward Current vs. Forward Voltage @ Temperatures — HSMS-2810 Series

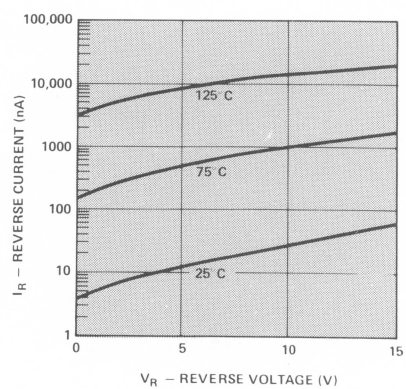


Figure 6. Reverse Current vs. Reverse Voltage @ Temperatures — HSMS-2810 Series

Typical Parameters (continued)

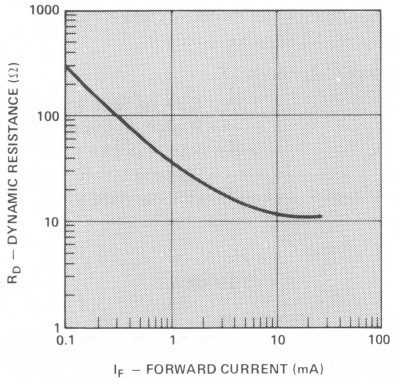


Figure 7. Dynamic Resistance vs. Forward Current HSMS-2810 Series

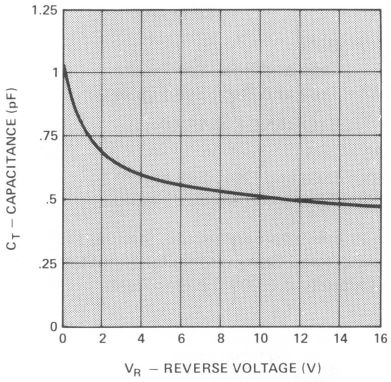


Figure 8. Total Capacitance vs. Reverse Voltage HSMS-2810 Series

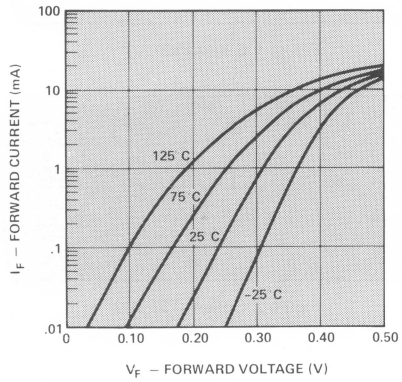


Figure 9. Forward Current vs. Forward Voltage @ Temperatures — HSMS-2820 Series

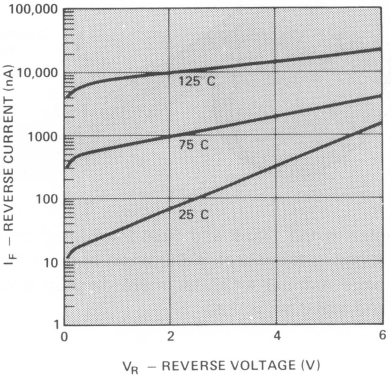


Figure 10. Reverse Current vs. Reverse Voltage @ Temperatures — HSMS-2820 Series

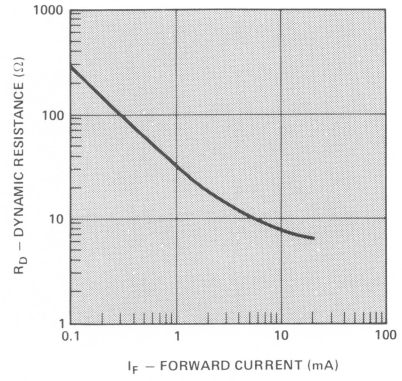


Figure 11. Dynamic Resistance vs. Forward Current HSMS-2820 Series

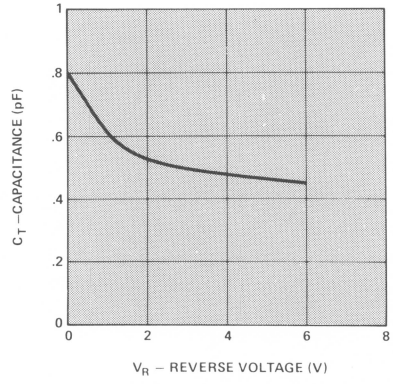


Figure 12. Total Capacitance vs. Reverse Voltage HSMS-2820 Series

Ordering Information

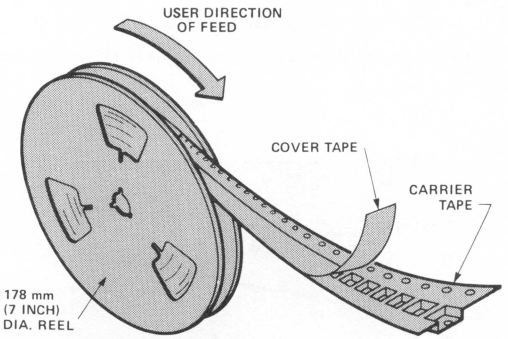
STANDARD PROFILE (WHITE MARKING)

Option T30 = Bulk
Option T31 = Tape and Reel, See Figure 1
Option T32 = Tape and Reel, See Figure 2

LOW PROFILE (ORANGE MARKING)

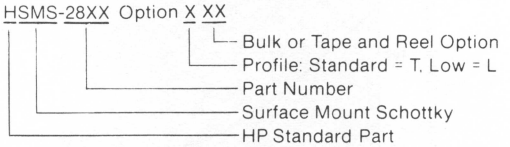
Option L30 = Bulk
Option L31 = Tape and Reel, See Figure 1
Option L32 = Tape and Reel, See Figure 2

Conforms to Electronic Industries Standard RS-481 "Taping of Surface Mounted Components for Automated Placement." Standard Quantity is 3,000 Devices/Reel.



Please refer to the "Tape and Reel Packaging for Surface Mount Devices" data sheet, publication number 5954-2077, catalog page number 4-127, for more detailed information on tape and reel dimensions.

Specify: Part Number followed by Option Number.
Example:



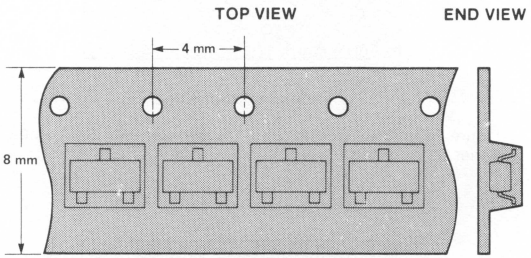


Figure 1. Options T31, L31

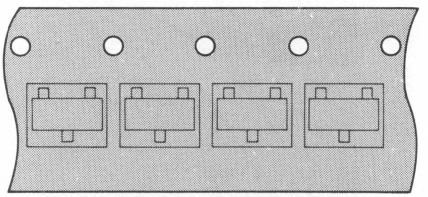


Figure 2. Options T32, L32

HEWLETT PACKARD

SCHOTTKY BARRIER DIODES FOR GENERAL PURPOSE APPLICATIONS

1N5711
1N5712
5082-2800/10/11/35
HSCH-1001 (1N6263)
5082-2301
5082-2302
5082-2303
5082-2305
5082-2900

Features

LOW TURN-ON VOLTAGE: AS LOW AS 0.34V AT 1mA

PICO-SECOND SWITCHING SPEED

HIGH BREAKDOWN VOLTAGE: UP TO 70V

MATCHED CHARACTERISTICS AVAILABLE

Description/Applications

The 1N5711, 1N5712, 5082-2800/10/11 are passivated Schottky barrier diodes which use a patented "guard ring" design to achieve a high breakdown voltage. Packaged in a low cost glass package, they are well suited for high level detecting, mixing, switching, gating, log or A-D converting, video detecting, frequency discriminating, sampling and wave shaping.

The 5082-2835 is a passivated Schottky diode in a low cost glass package. It is optimized for low turn-on voltage. The 5082-2835 is particularly well suited for the UHF mixing needs of the CATV marketplace.

The 5082-2300 and 2900 Series devices are unpassivated Schottky diodes in a glass package. These diodes have extremely low 1/f noise and are ideal for low noise mixing, and high sensitivity detecting. They are particularly well suited for use in Doppler or narrow band video receivers.

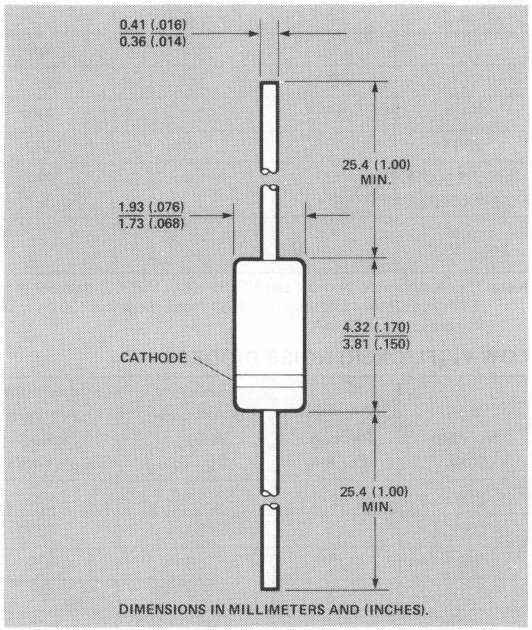
Application Bulletins 13, 14, 15, and 16 describe applications in which these diodes are used for speed up of a transistor, clipping, clamping, and sampling, respectively. Other digital and RF applications are described in Application Bulletins 26, 27, 28, 30, 31 and 36.

Maximum Ratings

Junction Operating and Storage Temperature Range
5082-2305, 2301, 2302, 2303, 2900 .... -60° C to +100° C
1N5711, 1N5712, 5082-2800/10/11, .. -65° C to +200° C
5082-2835 ..... -60° C to +150° C

DC Power Dissipation (Measured in an infinite heat sink at T_{CASE} = 25° C)
Derate linearly to zero at maximum rated temperature
5082-2305, 2301, 2302, 2303, 2900 ..... 100 mW
1N5711, 1N5712, 5082-2800/10/11 ..... 250 mW
5082-2835 ..... 150 mW

Peak Inverse Voltage ..... V_{BR}



OUTLINE 15

Package Characteristics

	Outline 15
Lead Material:	Dumet
Lead Finish:	1N5711, 1N5712; 95-5% Tin Lead 2800 Series; 95-5% Tin Lead 2300 Series; Gold 2900 Series; 95-5% Tin Lead
Maximum Soldering Temperature:	230° C for 5 sec.
Minimum Lead Strength:	4 lb. Pull
Typical Package Inductance:	1N5711, 1N5712: 2.0 nH 2800 Series: 2.0 nH 2300, 2900 Series: 3.0 nH
Typical Package Capacitance:	1N5711, 1N5712: 0.2 pF 2800 Series: 0.2 pF 2300, 2900 Series: 0.07 pF

The leads on the Outline 15 package should be restricted so that the bend starts at least 1/16 inch from the glass body.

Outline 12 and 15 diodes are available on tape and reel. The tape and reel specification is patterned after RS-296-D.

Electrical Specifications at $T_A = 25°C$

GENERAL PURPOSE DIODES

Part Number 5082-	Package Outline	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	V_F = 1 V Max at Forward Current I_F (mA)	Maximum Reverse Leakage Current I_R (nA) at V_R (V)		Maximum Capacitance C_T (pF)
2800	15	70	410	15	200	50	2.0
1N5711	15	70	410	15	200	50	2.0
2810	15	20	410	35	100	15	1.2
1N5712	15	20	550	35	150	16	1.2
2811	15	15	410	20	100	8	1.2
2835	15	8	340	10†	100	1	1.0
HSCH-1001* (1N6263)	12	60	410	15	200	50	2.2
Test Conditions		I_R = 10 μA I_R = 100 μA	I_F = 1 mA	†V_F = .45 V			V_R = 0 V f = 1.0 MHz

Note: *For further information, see HSCH-1001 (1N6263) data sheet in "Switching Diodes" section, page 000.
Effective Carrier Lifetime (τ) for all these diodes is 100 ps maximum measured with Krakauer method at 5 mA except for 5082-2835 which is measured at 20 mA.

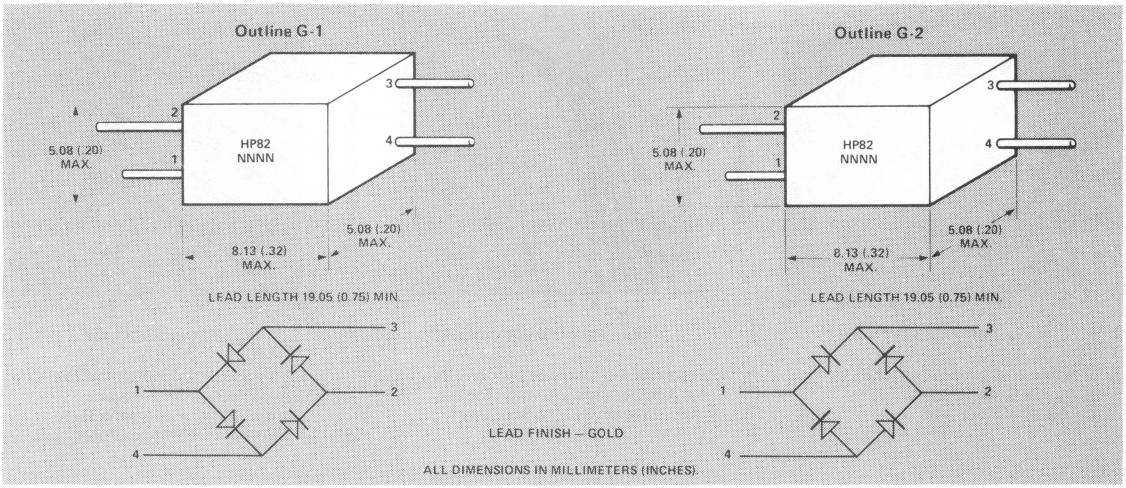
LOW V_F (FLICKER) NOISE DIODES

Part Number 5082-	Package Outline	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	V_F = 1 V Max at Forward Current I_F (mA)	Maximum Reverse Leakage Current I_R (nA) at V_R (V)		Maximum Capacitance C_T (pF)
2305	15	30	400	75	300	15	1.0
2301	15	30	400	50	300	15	1.0
2302	15	30	400	35	300	15	1.0
2303	15	20	400	35	500	15	1.0
2900	15	10	400	20	100	5	1.2
Test Conditions		I_R = 10 μA	I_F = 1 mA				V_R = 0 V f = 1.0 MHz

Note: Effective Carrier Lifetime (τ) for all these diodes is 100 ps maximum measured with Krakauer method at 20 mA.

Matched Pairs and Quads

Basic Part Number 5082-	Matched Pair Unconnected	Matched Quad Unconnected	Matched Ring Quad Encapsulated G-1 Outline	Matched Bridge Quad Encapsulated G-2 Outline	Batch Matched	Test Conditions
2301	5082-2306 ΔV_F = 20 mV ΔC_O = 0.2 pF					ΔV_F at I_F = 0.75, 20 mA ΔC_O at f = 1.0 MHz
2303	5082-2308 ΔV_F = 20 mV ΔC_O = 0.2 pF	5082-2370 ΔV_F = 20 mV ΔC_O = 0.2 pF	5082-2396 ΔV_F = 20 mV ΔC_O = 0.2 pF	5082-2356 ΔV_F = 20 mV ΔC_O = 0.2 pF		ΔV_F at I_F = 0.75, 20 mA ΔC_O at f = 1.0 MHz
2900	5082-2912 ΔV_F = 30 mV	5082-2970 ΔV_F = 30 mV		5082-2997 ΔV_F = 30 mV		ΔV_F at I_F = 1.0, 10 mA
2800	5082-2804 ΔV_F = 20 mV	5082-2805 ΔV_F = 20 mV			5082-2836* ΔV_F = 20 mV ΔC_O = 0.1 pF	ΔV_F at I_F = 0.5, 5 mA *I_F = 10 mA ΔC_O at f = 1.0 MHz
2811		5082-2815 ΔV_F = 20 mV ΔC_O = 0.2 pF	5082-2814 ΔV_F = 20 mV ΔC_O = 0.2 pF	5082-2813 ΔV_F = 20 mV ΔC_O = 0.2 pF	5082-2826 ΔV_F = 10 mV ΔC_O = 0.1 pF	ΔV_F at I_F = 10 mA ΔC_O at f = 1.0 MHz
2835					5082-2080 ΔV_F = 10 mV ΔC_O = 0.1 pF	ΔV_F at I_F = 10 mA ΔC_O at f = 1.0 MHz



Typical Parameters

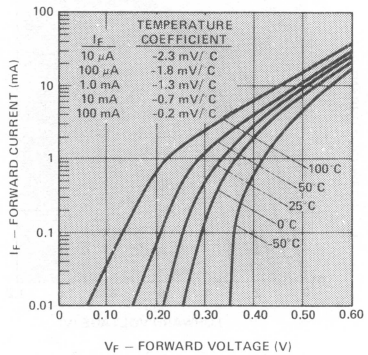


Figure 1. I-V Curve Showing Typical Temperature Variation for 5082-2300 and 5082-2900 Series Schottky Diodes.

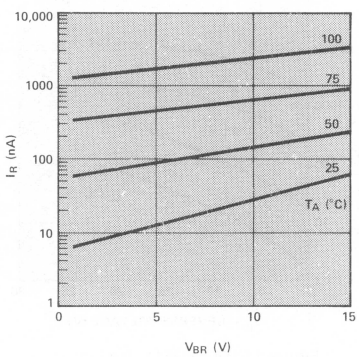


Figure 2. 5082-2300 Series Typical Reverse Current vs. Reverse Voltage at Various Temperatures.

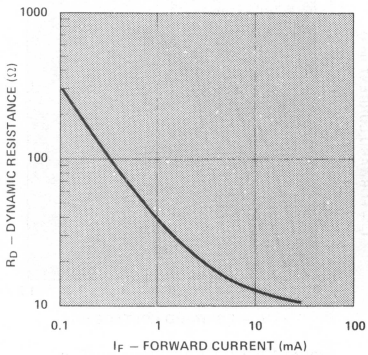


Figure 3. 5082-2300 Series and 5082-2900 Series Typical Dynamic Resistance (R_D) vs. Forward Current (I_F).

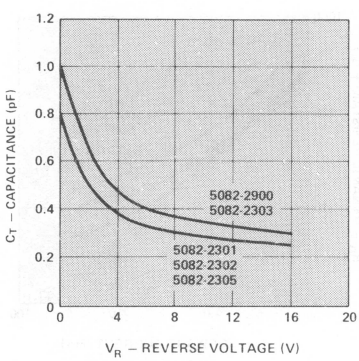


Figure 4. 5082-2300 and 5082-2900 Series Typical Capacitance vs. Reverse Voltage.

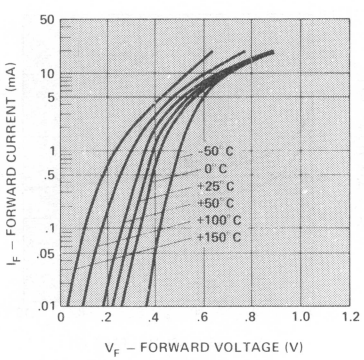


Figure 5. I-V Curve Showing Typical Temperature Variation for 5082-2800 or 1N5711 Schottky Diodes.

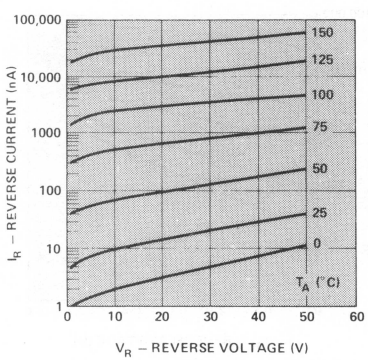


Figure 6. (5082-2800 or 1N5711) Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures.

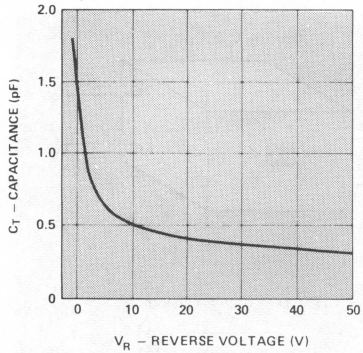


Figure 7. (5082-2800 or 1N5711) Typical Capacitance (C_T) vs. Reverse Voltage (V_R).

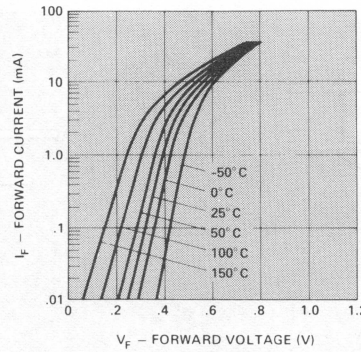


Figure 8. I-V Curve Showing Typical Temperature Variation for the 5082-2810 or 1N5712 Schottky Diode.

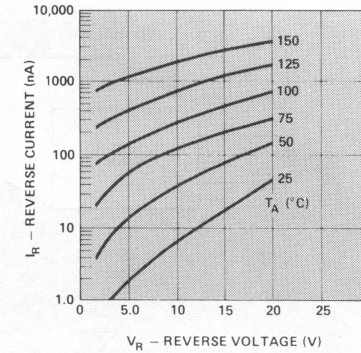


Figure 9. (5082-2810 or 1N5712) Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures.

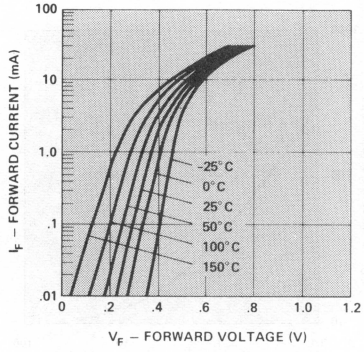


Figure 10. I-V Curve Showing Typical Temperature Variation for the 5082-2811 Schottky Diode.

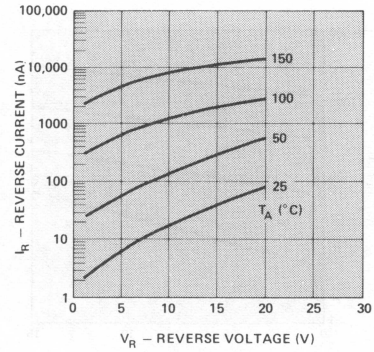


Figure 11. (5082-2811) Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures.

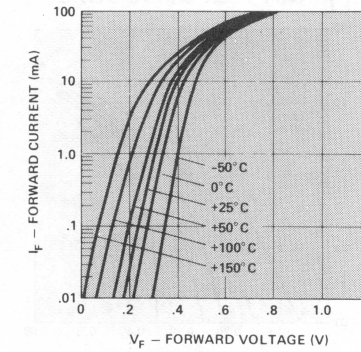


Figure 12. I-V Curve Showing Typical Temperature Variations for 5082-2835 Schottky Diode.

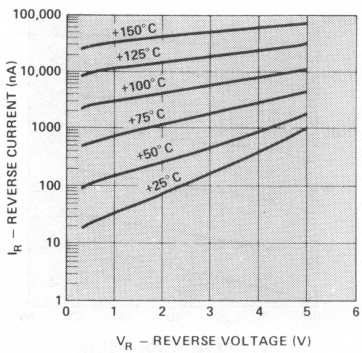


Figure 13. (5082-2835) Typical Variation of Reverse Current (I_R) vs. Reverse Voltage (V_R) at Various Temperatures.

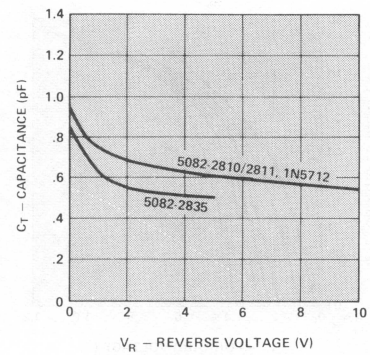


Figure 14. Typical Capacitance (C_T) vs. Reverse Voltage (V_R).

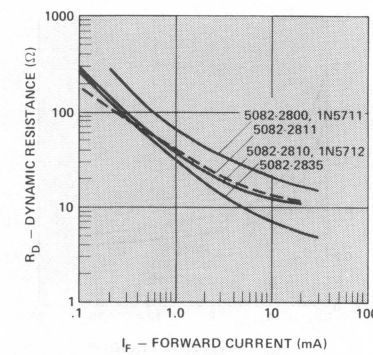


Figure 15. Typical Dynamic Resistance (R_D) vs. Forward Current (I_F).

HEWLETT PACKARD

HERMETIC SCHOTTKY DIODES FOR MIXERS AND DETECTORS (1-18 GHz)

NEW

HSCH-6000 SERIES

Features

LOW PARASITIC HERMETIC PACKAGE
- **High Frequency Performance**
- **Meets Performance Standards of Space Level Testing**

LEAD FORMING OPTION
- **No Board Drilling Required**

RUGGED CONSTRUCTION
- **MIL-STD-750 Compliance**

HIGH UNIFORMITY
- **Tightly Controlled Process Insures Consistent Performance**

SILICON NITRIDE PASSIVATION, TRI-METALLIZATION
- **Stable High Temperature Performance**

Description

These Schottky barrier diodes are fabricated by advanced epitaxial techniques. Precise process control insures uniformity and repeatability of this planar beam lead microwave semiconductor. A nitride passivation layer provides immunity from contaminants which could otherwise lead to I_R drift.

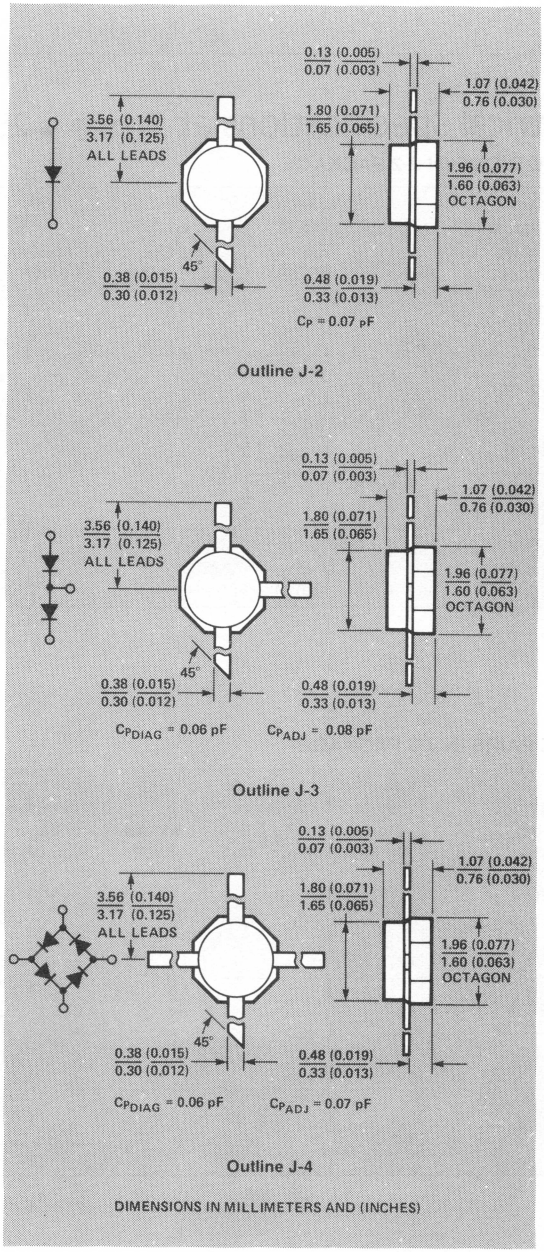
These diodes are packaged in the hermetic J package. Advanced design and assembly processes minimize package parasitics resulting in optimum performance.

The body of the package is alumina, while the leads are gold-plated over nickel-plated Kovar. The solder glass seal and rugged construction meet the stringent requirements of space-level testing and are capable of meeting the environmental tests of MIL-STD-750, and hi-rel programs described on pages 000-000 of the catalog.

Applications

These hermetic devices are designed for stripline and microstrip use. The design features extremely low package parasitics. The package outline also maximizes lead strength while reducing overall body size. This design is especially useful in environments requiring high frequency and/or wide band operation.

The single diode can be used in either mixer or detector applications. The pairs can be used in balanced mixers and can be configured to assemble bridge, star, and ring quads for Class I, II, or III type double balanced mixers. The quads are used as double balanced mixers, phase detectors, and AM and digital modulators.



Maximum Ratings

Pulse Power Incident at T_{CASE} = 25° C
(1 μs pulse, DC = 0.001) ..... 1 W
CW Power Dissipation at T_{CASE} = 25° C
Derate linearly to zero at 175° C ..... 150 mW
Operating Temperature Range ..... −65° C to +175° C
Storage Temperature Range ..... −65° C to +200° C
Soldering Temperature ..... 290° C Max. for 10 sec.

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Electrical Specifications at T_{CASE} = 25° C

SINGLE DIODE IN J-2 PACKAGE

Part Number HSCH-	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	Max.	Maximum SWR	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Maximum Total Capacitance C_T (pF)	Maximum Forward Voltage V_F (mV)
6310	Medium	7.2 at 16 GHz	200	400	1.5:1	4	20	0.17	500
6312		6.2 at 9.375 GHz					16	0.22	
6330	Low	7.2 at 16 GHz	150	350			20	0.17	375
6332		6.2 at 9.375 GHz					16	0.22	
Test Conditions		DC Load Resistance = 0 Ω L.O. Power = 1 mW I_F = 30 MHz, 1.5 dB NF				$I_R \leq 10$ μA	I_F = 5 mA	V_R = 0 V f = 1 MHz	I_F = 1 mA

DIODE PAIRS IN J-3 PACKAGE

Part Number HSCH-	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	Max.	Maximum SWR	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Max. ΔR_D (Ω)	Maximum Total Capacitance C_T (pF)	Max. ΔC_T (pF)	Maximum Forward Voltage V_F (mV)	Max. ΔV_F (mV)
6510	Medium	7.2 at 16 GHz	200	400	1.5:1	4	20	3	0.18	0.02	500	10
6512		6.2 at 9.375 GHz					16		0.23			
6530	Low	7.2 at 16 GHz	150	350			20		0.18		375	
6532		6.2 at 9.375 GHz					16		0.23			
Test Conditions		DC Load Resistance = 0 Ω L.O. Power = 1 mW I_F = 30 MHz, 1.5 dB NF				$I_R \leq 10$ μA	I_F = 5 mA		V_R = 0 V f = 1 MHz		I_F = 1 mA	
						Measured between adjacent leads.						

DIODE QUADS IN J-4 PACKAGE

Frequency Band	Part Number HSCH-	Barrier	Maximum Capacitance C_T (pF)		Maximum Adjacent Capacitance Difference ΔC_T (pF)	Maximum Dynamic Resistance R_D (Ω)	Maximum Resistance Difference ΔR_D (Ω)	Maximum Forward Voltage V_F (mV)	Maximum V_F Difference ΔV_F (mV)
			Diagonal	Adjacent					
Ku	6810	Medium	0.16	0.21	0.03	20	3	500	15
18 GHz	6830	Low						375	
X	6812	Medium	0.21	0.28		16	2	500	
12 GHz	6832	Low						375	
Test Conditions			$V_R = 0$ V, f = 1 MHz			$I_F = 5$ mA		$I_F = 1$ mA	
						Measured between adjacent leads.			

Typical Parameters

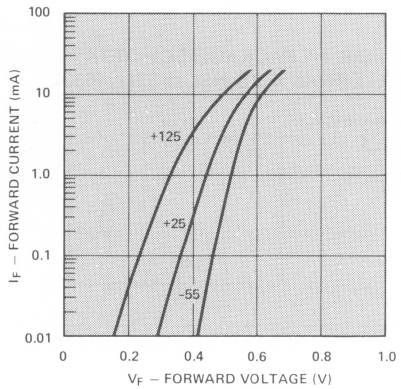


Figure 1. Typical Forward Characteristics for Medium Barrier Diodes.

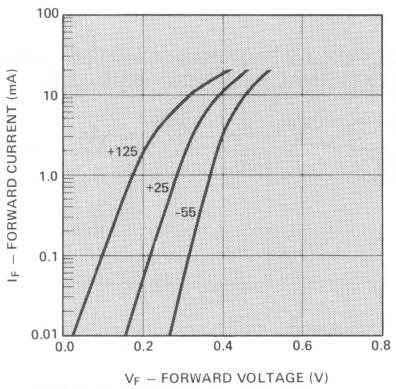


Figure 2. Typical Forward Characteristics for Low Barrier Diodes.

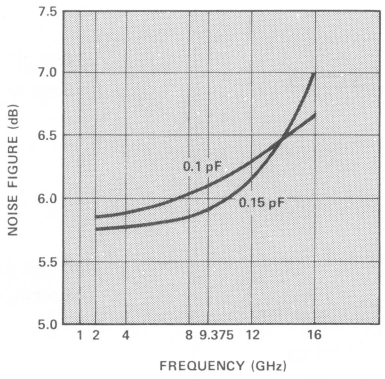


Figure 3. Typical Noise Figure vs. Frequency for J-Packages.

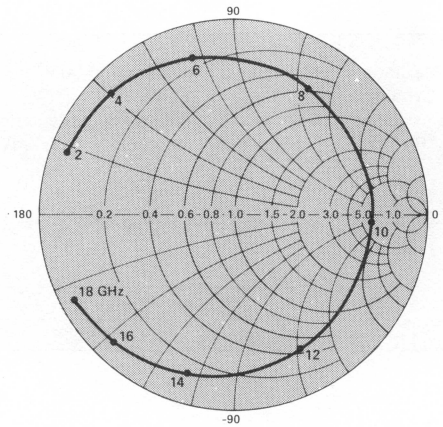


Figure 4. Typical Admittance Characteristics with 20μA External Bias. HSCH-6310, -6330.

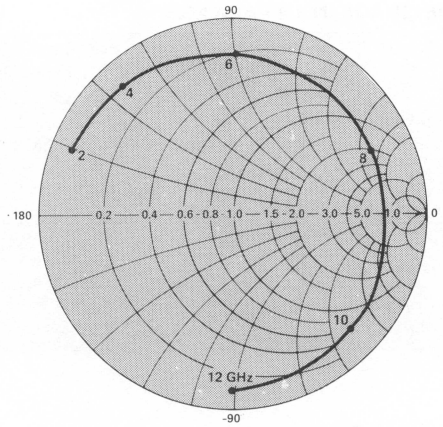
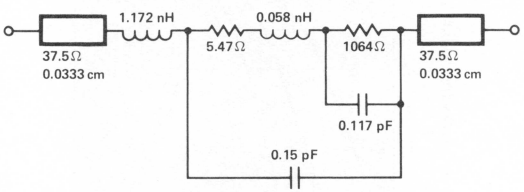
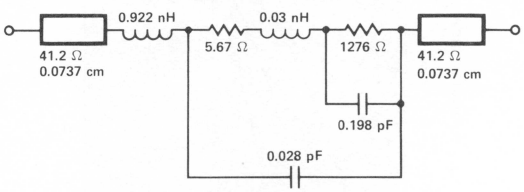


Figure 5. Typical Admittance Characteristics with 20μA External Bias. HSCH-6312, -6332.

MODEL FOR J-2 PACKAGE SCHOTTKY DIODES AT 20 μA EXTERNAL BIAS HSCH-6310, -6330

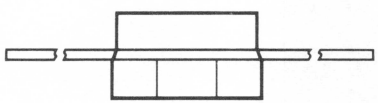


MODEL FOR J-2 PACKAGE SCHOTTKY DIODES AT 20 μA EXTERNAL BIAS HSCH-6312, -6332



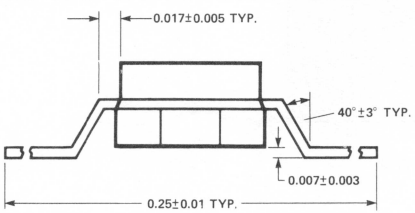
Special Order Information

In the event that mounting these diodes in the circuit requires leads formed as shown below, this lead configuration can be ordered directly. Please refer to the following table for order information.



Straight Lead Order Information

Specify: Part Number (HSCH-6XXX)
No Option Required



Formed Lead Order Information

Specify: Part Number (HSCH-6XXX)
Option Number F01
All electrical tests are made prior to lead forming.

HEWLETT PACKARD

SCHOTTKY BARRIER DIODES FOR STRIPLINE, MICROSTRIP MIXERS AND DETECTORS

5082-2200/01/02/03
5082-2207/08/09/10
5082-2765/66
5082-2774/75
5082-2785/86
5082-2794/95

Features

SMALL SIZE

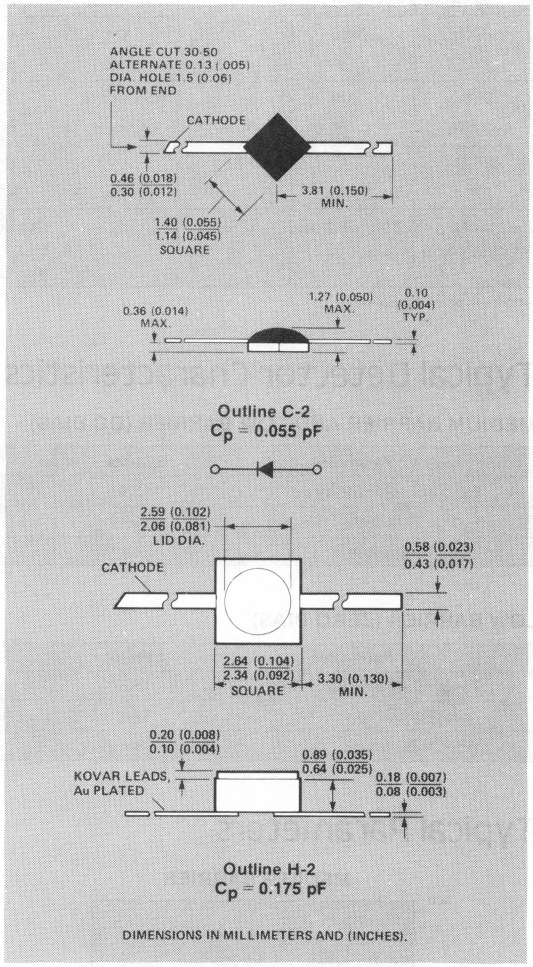
LOW NOISE FIGURE
6 dB Typical at 9 GHz

RUGGED DESIGN

HIGH UNIFORMITY

HIGH BURNOUT RATING
1 W RF Pulse Power Incident

BOTH MEDIUM AND LOW BARRIER AVAILABLE



Description/Applications

This family consists of medium barrier and low barrier beam lead diodes mounted in easily handled carrier packages. Low barrier diodes provide optimum noise figure at low local oscillator drive levels. Medium barrier diodes provide a wider dynamic range for lower distortion mixer designs. Application Note 976 presents impedance matching techniques for an X-Band mixer.

Maximum Ratings

Operating and Storage Temperature Range
C-2 Packaged Diodes ..... −65° C to +125° C
H-2 Packaged Diodes ..... −65° C to +175° C
Pulse Power Incident at T_{CASE} = 25° C ..... 1 W
(1 μs pulse, Du = 0.001)

CW Power Dissipation at T_{CASE} = 25° C
(Mounted in infinite Heat Sink) ..... 125 mW
(Derate linearly to Zero at Maximum Operating Temperature)

Diode Mounting Temperature in Packages
C-2 ..... 235° C for 10 sec max.
H-2 ..... 260° C for 10 sec max.

Peak Inverse Voltage ..... 4 V

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Package Characteristics

These diodes are designed for microstrip and stripline use. The kovar leads provide good continuity of transmission line impedance to the diode. Outline C2 is a plastic on ceramic package. Outline H2 has a metal ceramic hermetic seal. The ceramic is alumina. Metal parts are gold plated kovar.

The hermetic package, outline H2, is capable of passing many of the environmental tests of MIL-STD-750. The applicable solderability test is reference 2031.1: 260° C, 10 seconds.

RF Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Batch Matched* 5082-	Test Freq. (GHz)	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	Max.	Maximum SWR	Package	Typical Capacitance C_T (pF)
2200	2201	9.375	Medium	6.0	200	400	1.5:1	Hermetic H-2	0.3
2202	2203		Medium	6.5			2.0:1		
2765	2766		Low	6.0	150	350	1.5:1		
2785	2786		Low	6.5			2.0:1		
2207	2208		Medium	6.0	200	400	1.5:1	Broadband C-2	0.22
2209	2210		Medium	6.5			2.0:1		
2774	2775		Low	6.0	150	350	1.5:1		
2794	2795		Low	6.5			2.0:1		
Test Conditions	$\Delta NF \leq 0.3$ dB $\Delta Z_{IF} \leq 25\ \Omega$			DC Load Resistance = 0 Ω L.O. Power = 1 mW IF = 30 MHz, 1.5 dB NF					V = 0

*Minimum batch size 20 units.

Typical Detector Characteristics at $T_A = 25°C$

MEDIUM BARRIER AND LOW BARRIER (DC BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-54	dBm	20μA Bias
Voltage Sensitivity	γ	6.6	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	R_V	1400	Ω	f = 10 GHz

LOW BARRIER (ZERO BIAS)

Parameter	Symbol	Typical Value	Units	Test Conditions
Tangential Sensitivity	TSS	-44	dBm	Zero Bias
Voltage Sensitivity	γ	10	mV/μW	Video Bandwidth = 2 MHz
Video Resistance	R_V	1.8	MΩ	f = 10 GHz

Typical Parameters

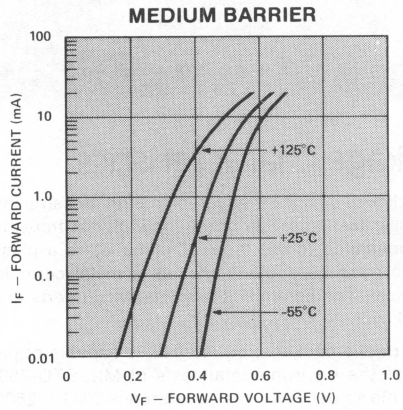


Figure 1. Typical Forward Characteristics

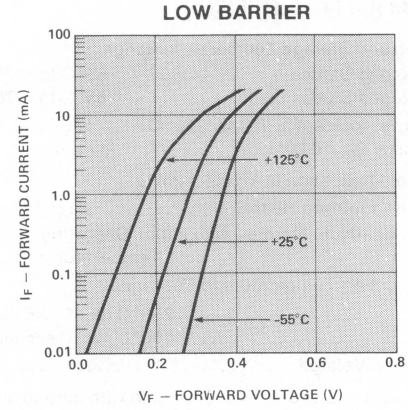


Figure 2. Typical Forward Characteristics

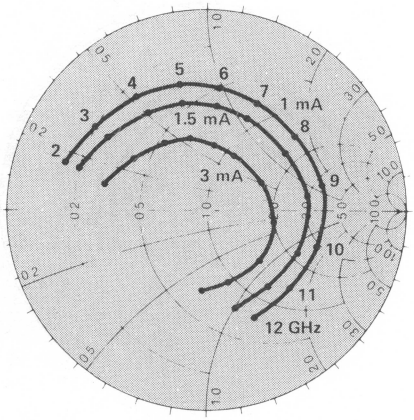


Figure 3. Typical Admittance Characteristics, 5082-2200 and 5082-2765 with self bias.

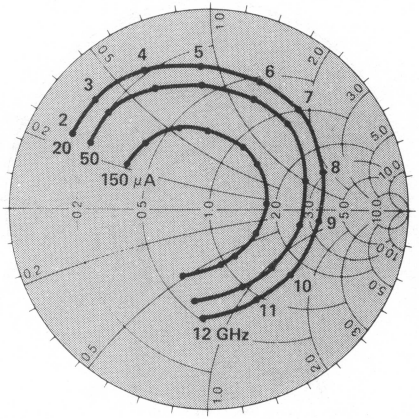


Figure 4. Typical Admittance Characteristics, 5082-2200 and 5082-2765 with external bias.

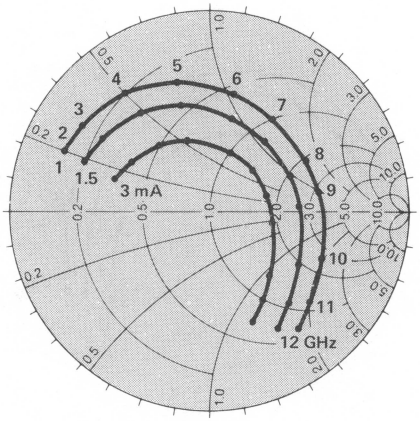


Figure 5. Typical Admittance Characteristics, 5082-2202 and 5082-2785 with self bias.

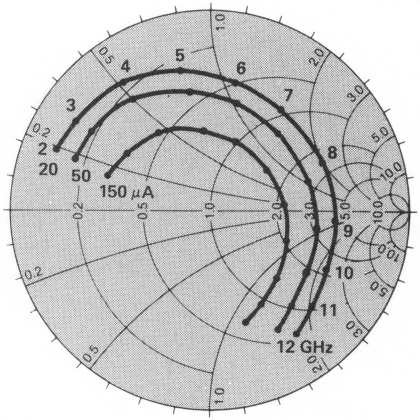


Figure 6. Typical Admittance Characteristics, 5082-2202 and 5082-2785 with external bias.

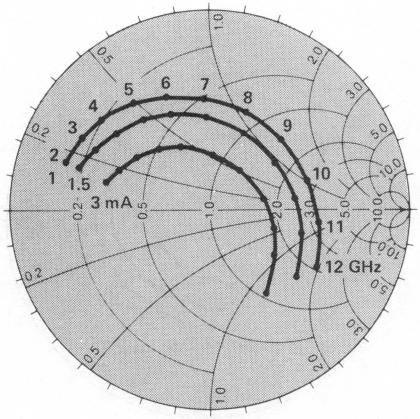


Figure 7. Typical Admittance Characteristics, 5082-2207 and 5082-2774 with self bias.

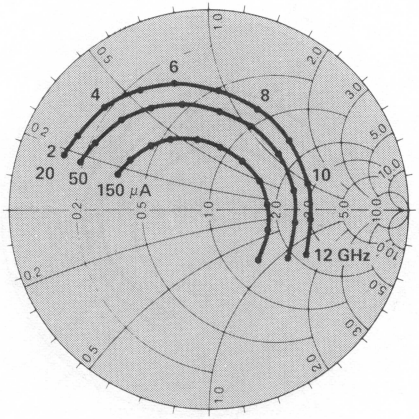


Figure 8. Typical Admittance Characteristics, 5082-2207 and 5082-2774 with external bias.

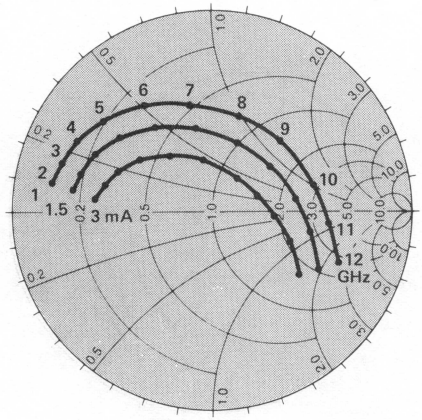


Figure 9. Typical Admittance Characteristics, 5082-2209 and 5082-2794 with self bias.

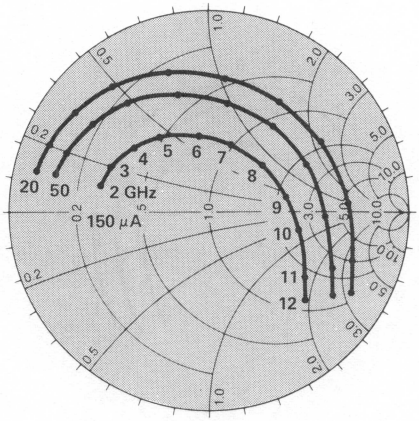


Figure 10. Typical Admittance Characteristics, 5082-2209 and 5082-2794 with external bias.

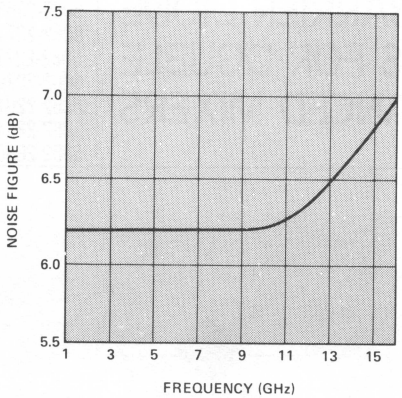
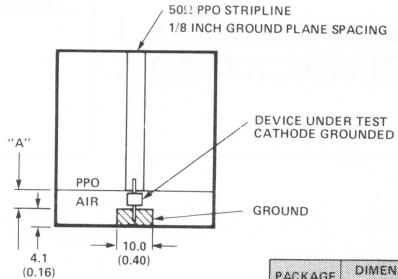


Figure 11. Typical Noise Figure vs. Frequency for 5082-2209, 2794.

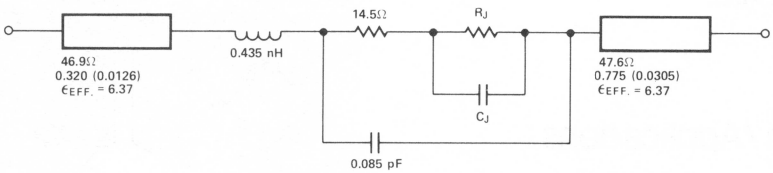


PACKAGE	DIMENSION "A"
C-2	1.91 ± 0.05 (0.075 ± 0.002)
H-2	2.67 ± 0.05 (0.105 ± 0.002)

DIMENSIONS IN MILLIMETERS (INCHES)

Figure 12. Admittance Test Circuit.

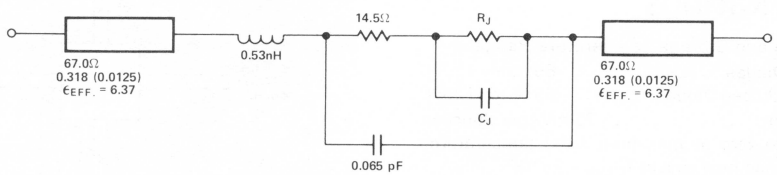
MODEL FOR H2 DIODES



DIMENSIONS IN MILLIMETERS (INCHES)

Parameter	Symbol	1 mA Rect. Current 5082-2200, 5082-2765	20 μA Ext. Bias 5082-2200, 5082-2765	Units
Junction Resistance	R_J	258	545	Ohms
Junction Capacitance	C_J	0.255	0.302	pF

MODEL FOR C-2 DIODES



DIMENSIONS IN MILLIMETERS (INCHES)

Parameter	Symbol	1 mA Rect. Current 5082-2207, 5082-2774	20 μA Ext. Bias 5082-2207, 5082-2774	Units
Junction Resistance	R_J	338	421	Ohms
Junction Capacitance	C_J	0.189	0.195	pF

HEWLETT PACKARD

SCHOTTKY BARRIER DIODE QUADS FOR DOUBLE BALANCED MIXERS

5082-2231
5082-2233
5082-2263
5082-2271/72
5082-2277
5082-2279/80
5082-2291/92
5082-2294
5082-2830/31

Features

SMALL SIZE
Eases Broad Band Designs

TIGHT MATCH
Improves Mixer Balance

IMPROVED BALANCE OVER TEMPERATURE

RUGGED DESIGN

BOTH MEDIUM AND LOW BARRIER DIODES AVAILABLE

Description / Applications

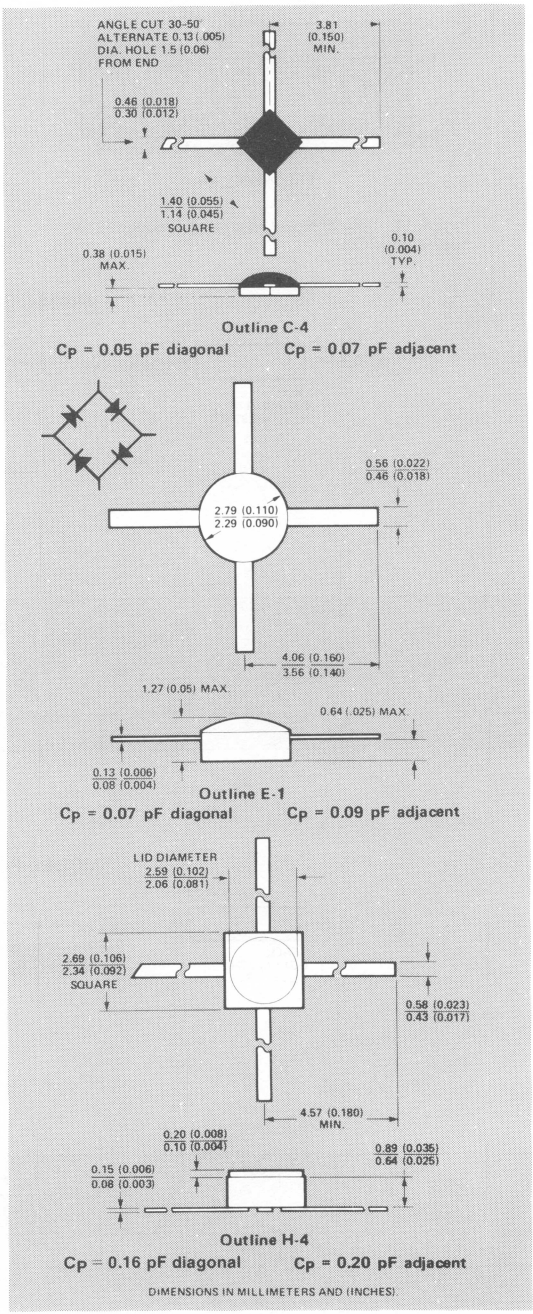
These matched diode quads use a monolithic array of Schottky diodes interconnected in ring configuration. The relative proximity of the diode junction on the wafer assures uniform electrical characteristics and temperature tracking.

These diodes are designed for use in double balanced mixers, phase detectors, AM modulators, and pulse modulators requiring wideband operation and small size. The low barrier diodes allow for optimum mixer noise figure at lower than conventional local oscillator levels. The wider dynamic range of the medium barrier diodes allows for better distortion performance.

Maximum Ratings

Junction Operating and Storage Temperature Range:
H-4 Packaged Diodes ..... -65°C to +150°C
E-1 and C-4 Packaged Diodes ..... -65°C to +125°C
DC Power Dissipation ..... 75 mW per Junction
Derate linearly to zero at maximum rated temperatures (measured in infinite heat sink at T_{CASE} = 25° C)
Soldering Temperature ..... H-4 260° C for 10 sec.
C-4 235° C for 10 sec.
E-1 220° C for 10 sec.

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.



Selection Guide

Package Outline \ Frequency	Barrier	To 2 GHz	2-4 GHz	4-8 GHz	8-12 GHz	12-18 GHz
E-1	Medium	5082-2830	5082-2277	5082-2277		
Low Cost	Low	5082-2831				
H-4	Medium	5082-2263	5082-2263	5082-2263		
Hermetic	Low	5082-2231	5082-2231	5082-2233		
C-4	Medium	5082-2291	5082-2291	5082-2292	5082-2294	5082-2294
Broadband	Low	5082-2271	5082-2271	5082-2272	5082-2279	5082-2280

Electrical Characteristics at T_A=25°C

Part Number 5082-	Package	Barrier	Maximum Capacitance C_T (pF)		Maximum Capacitance Difference ΔC_T (pF)	Maximum V_F Difference ΔV_F (mV)	Maximum Dynamic Resistance R_D (Ω)	Typical Parameters: Forward Voltage V_F (V)
			Diagonal	Adjacent				
2231	H-4	Low	0.60	0.80	0.10	20	12	0.25
2233			0.40	0.54	0.05		16	0.30
2263		Medium	0.40	0.54	0.05		16	0.45
2830	E-1		0.5 Typ.	0.67 Typ.	0.20		12	0.40
2831		Low	0.5 Typ.	0.67 Typ.	0.20		12	0.25
2277		Medium	0.50	0.67	0.10		15	0.35
2271	C-4	Low	0.60	0.80	0.10		12	0.25
2272			0.40	0.54	0.10		15	0.25
2279			0.25	0.34	0.05		16	0.30
2280			0.20	0.27	0.05		16	0.30
2291		Medium	0.60	0.80	0.10		12	0.35
2292			0.40	0.54	0.10		15	0.35
2294			0.20	0.27	0.05		16	0.45
Test Conditions			V_R = 0 f = 1 MHz			I_F = 5 mA between Adjacent Leads		I_F = 1 mA Measured between Adjacent Leads

Package Characteristics

The HP outline E1 package is designed for MIC, Microstrip, and Stripline use from dc through X-Band. The leads provide a good continuity of transmission line impedance to the monolithic diode array. The leads are tin plated copper.

The C-4 subminiature package is a ceramic carrier whose gold plated kovar leads are brazed to the substrate for maximum package ruggedness. If the leads are to be formed, they should be restricted so the bend starts at least 0.25 mm (0.01 inch) from the package body. The semiconductor is protected from mechanical abrasion by epoxy. The H-4 miniature package is a hermetic metal-ceramic device, which makes it ideal for applications requiring high reliability. The leads are gold plated kovar. Outline H-4 is capable of passing many of the environmental tests of MIL-STD-750. The applicable solderability test is reference 2031.1: 260° C, 10 seconds.

Dynamic and Series Resistance

Schottky diode resistance may be expressed as series resistance, R_S, or as dynamic resistance, R_D. The two terms are related by the equation

$$R_D = R_S + R_j$$

where R_j is the resistance of the junction. Junction resistance of a diode with DC bias is quite accurately calculated by

$$R_j = 26/I_B \quad \text{where}$$

I_B is the bias current in milliamperes. The series resistance is independent of current.

The dynamic resistance is more easily measured. If series resistance is specified it is usually obtained by subtracting the calculated junction resistance from the measured dynamic resistance.

Diagonal and Adjacent Capacitance

In a ring quad, DIAGONAL CAPACITANCE is the capacitance tested between points A and B as shown in Figure 1. The diagonal capacitance measurement has the same value as the individual diode in the quad.

Example:

$$C_{DIAGONAL} = \frac{C_1 \times C_2}{C_1 + C_2} + \frac{C_3 \times C_4}{C_3 + C_4}$$

Assuming $C_1 = C_2 = C_3 = C_4 = 1.0$ pF

$C_{DIAGONAL} = 1/2 + 1/2 = 1.0$ pF

The capacitance value of the individual diode measured across points A and C in Figure 1 is the ADJACENT CAPACITANCE. The adjacent capacitance measurement of the individual diode contains some capacitive elements of the other diodes in the ring quad.

Example:

$$C_{ADJACENT} = C_1 + \frac{1}{\frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4}}$$

Assuming $C_1 = C_2 = C_3 = C_4 = 1.0$ pF

$C_{ADJACENT} = 1 + 1/3 = 1.333$ pF

Therefore, the adjacent capacitance value of the individual diode in the Schottky ring quad is 33% higher than the actual (diagonal) capacitance value. I.E. $C_{ADJACENT} = 1.333 \times C_{DIAGONAL}$.

Hewlett-Packard guarantees maximum capacitance through 100% testing to the limits shown on the data sheet. Maximum adjacent capacitance values have been calculated.

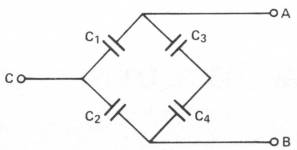


Figure 1.

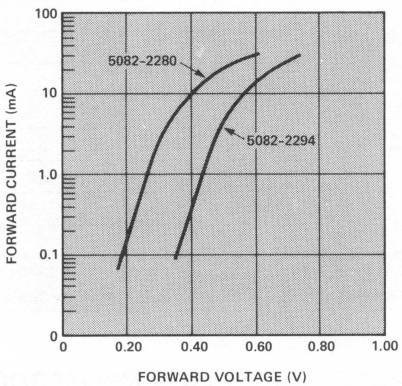


Figure 2. Typical Forward Characteristics at $T_A = 25°C$

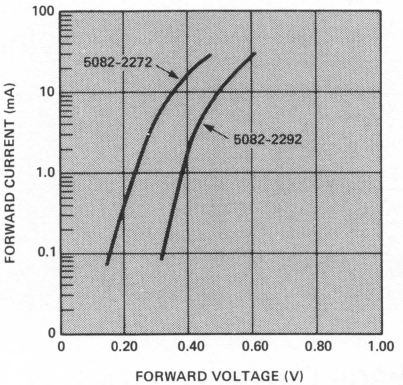


Figure 3. Typical Forward Characteristics at $T_A = 25°C$

HEWLETT PACKARD

SCHOTTKY BARRIER DIODES FOR MIXERS AND DETECTORS

5082-2273/74
5082-2295-98
5082-2350/51
5082-2400/01
5082-2520/21/65/66
5082-2701/02/06/07
5082-2711-14/23-24
5082-2817/18

Features

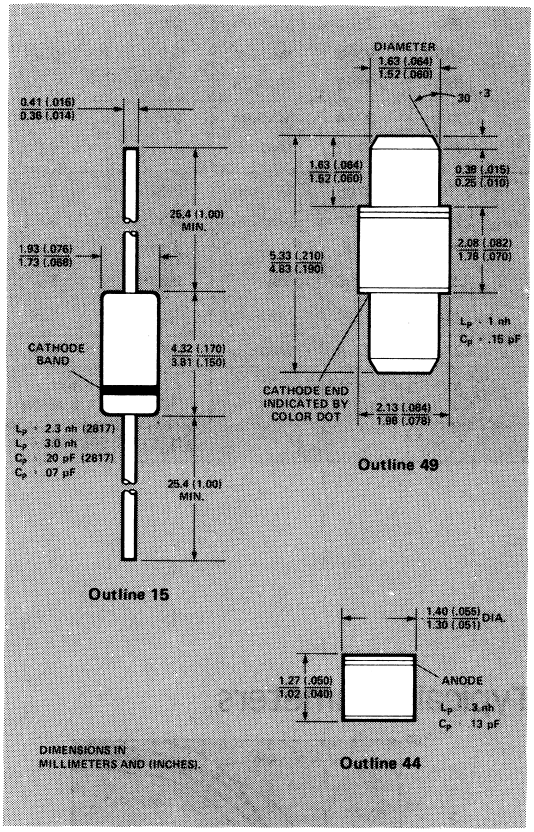
LOW NOISE FIGURE

HIGH BURNOUT RATING
15 W RF Pulse Power Incident

RUGGED DESIGN

HIGH UNIFORMITY

BOTH MEDIUM AND LOW BARRIER DIODES AVAILABLE



Description / Applications

These Schottky diodes are optimized for use in broad band and narrow band microstrip, coaxial, or waveguide mixer assemblies operating to 18 GHz. The low barrier diodes give optimum noise figure performance at low local oscillator drive levels. Medium barrier diodes provide a wider dynamic range for lower distortion mixer designs. The 5082-2350, -2400, -2520 and -2565 have extremely low 1/f noise, making them ideal for use as Doppler mixers.

Maximum Ratings

Junction Operating and Storage Temperature Range
5082-2400, -2401, -2565, -2566, -2350, -2351, -2520, 2521 ..... −60° C to +100° C
5082-2817, -2818 ..... −60° C to +200° C
All other diodes ..... −60° C to +150° C

CW Power Dissipation (Measured in an infinite heat sink)
Derate linearly to 0 W at max. rated temperature at T_{CASE} = 25° C
5082-2300, -2400, -2500 Series ..... 100 mW
5082-2817, -2818 ..... 250 mW
Others ..... 200 mW

Pulse Power Dissipation
Peak power absorbed by the diode at T_{CASE} = 25° C
1 μs pulse, Du = 0.001 ..... 1 W

Soldering Temperature ..... 230° C for 5 sec.

Note: The 5082-2200, -2500 and -2700 series are ESD sensitive. Handle with care to avoid static discharge through the diode.

Package Characteristics

The HP Outline 15 package has a glass hermetic seal with plated Dumet leads which should be restricted so that the bend starts at least 1/16" (1.6 mm) from the glass body. With this restriction, it will meet MIL-STD-750. Method 2036, Conditions A and E (4 lb. [1.8 kg] tension for 30 minutes). The maximum soldering temperature is 230° C for 5 seconds. Marking is by digital coding with a cathode band.

The HP Outline 49 package has a metal-ceramic hermetic seal. The anode and cathode studs are gold-plated Kovar. The maximum soldering temperature is 230° C for 5 seconds. Stud-stud T/R is 0.010" max.

The HP Outline 44 package is a hermetically sealed ceramic package. The anode and cathode are gold-plated Kovar. The maximum soldering temperature is 230° C for 5 seconds.

Electrical Specifications at $T_A = 25°C$

Typical Parameters

Part Number 5082-	Matched Pair 5082-	Barrier	LO Test Frequency (GHz)	Maximum SSB Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	IF Impedance Z_{IF} (Ω) Max.	Maximum SWR	Package Outline	Junction Capacitance C_{JO} (pF)	Breakdown Voltage V_{BR} (V)
2817	2818	Medium	2.0	6.0	250	400	1.5:1		1.0	15
2400	2401	Medium	2.0	6.0	150	250	1.3:1		0.7	30
2350	2351	Medium	2.0	7.0	150	250	1.5:1	15	0.9	30
2565	2566	Medium	3.0	6.0	100	250	1.5:1		0.7	5
2520	2521	Medium	3.0	7.0	100	250	1.5:1		0.7	5
2713	2714	Medium	9.375	6.0	200	400	1.5:1	49		
2711	2712	Medium	9.375	6.5	200	400	2.0:1			
2701	2706	Medium	9.375	6.0	200	400	1.5:1			4
2702	2707	Medium	9.375	6.5	200	400	1.5:1	44	0.10	
2295	2296	Low	9.375	6.0	100	250	1.5:1			
2297	2298	Low	9.375	6.5	100	250	2.0:1			
2723	2724	Medium	16	6.5	200	400	1.5:1	49		3
2273	2274	Medium	16	6.5	200	400	1.5:1	44		3
Test Conditions	$\Delta NF \leq 0.3dB$ $\Delta Z_{IF} \leq 25\Omega$		LO Power = 1 mW IF=30 MHz, 1.5 dB NF Zero DC Load Resistance (100Ω for 5082-2817)		Same as for NF except IF = 10 KHz		Same as for NF		V = 0	$I_R = 10\ \mu A$

Typical Parameters

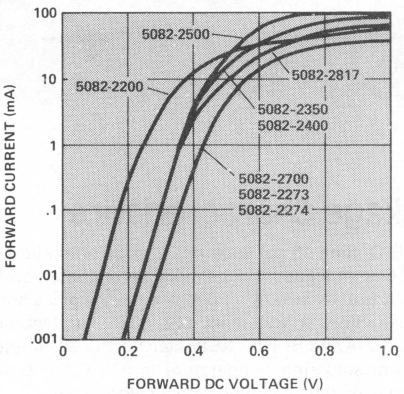


Figure 1. Typical Forward Characteristics at $T_A = 25°C$.

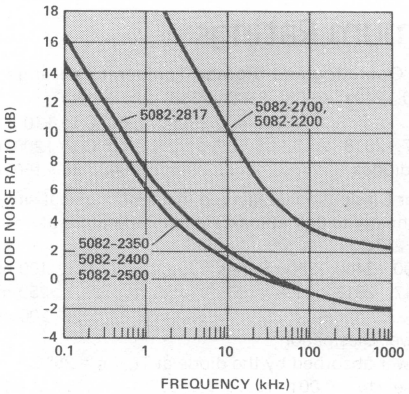


Figure 2. Typical Diode Noise Ratio vs. Frequency at 1 mA Current.

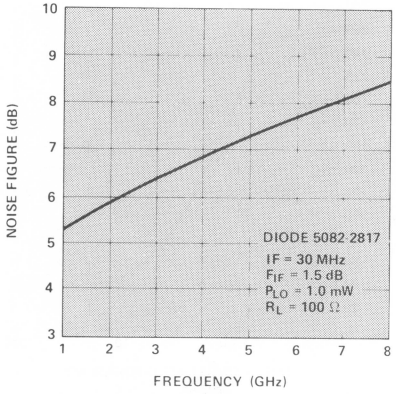


Figure 3. Typical Noise Figure vs. Frequency. The mount is tuned for minimum noise figure at each frequency.

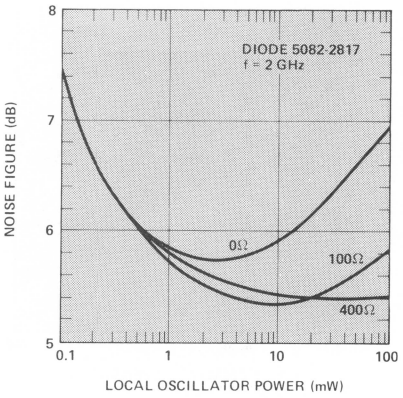


Figure 4. Single Sideband Noise Figure (including an IF-amplifier noise figure of 1.5 dB) vs. Incident LO Power for Various DC-load Resistances R_L. (The mount is tuned for minimum noise figure at each LO power level).

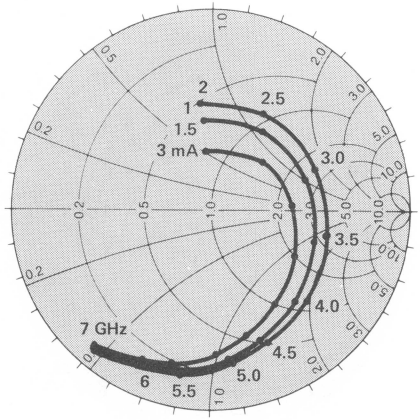


Figure 5. Typical Admittance Characteristics, 5082-2817 with Self Bias.

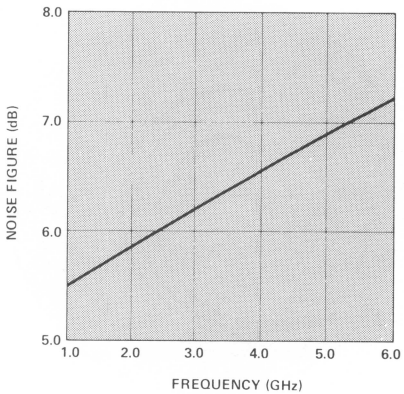


Figure 6. Typical HP 5082-2400 Noise Figure vs. Frequency with P_{LO} = 1.0 mW, IF = 30 MHz, and NF_{IF} = 1.5 dB. Mount Tuned at Each Frequency.

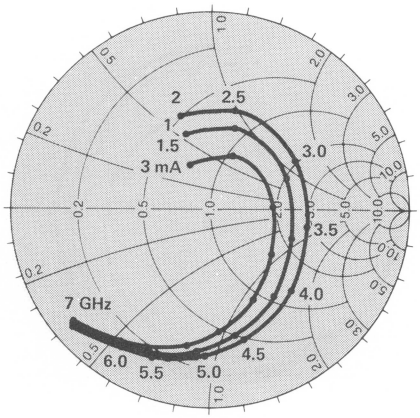


Figure 7. Typical Admittance Characteristics, 5082-2400 with Self Bias.

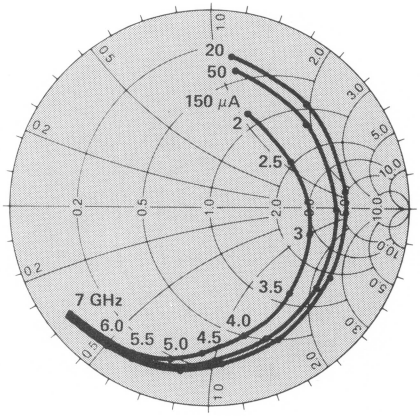


Figure 8. Typical Admittance Characteristics, 5082-2400 with External Bias.

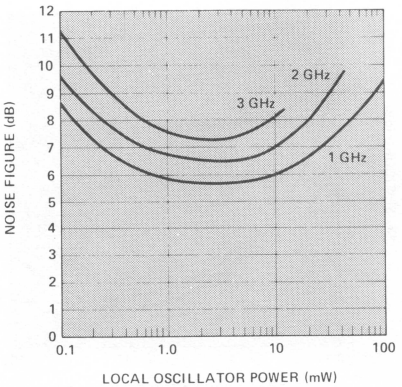


Figure 9. Typical HP 5082-2350 Noise Figure vs. Local Oscillator Power at 1.0, 2.0 and 3.0 GHz with IF = 30 MHz and NF_{IF} = 1.5 dB. (The Mount is tuned for Minimum Noise Figure at each LO Level).

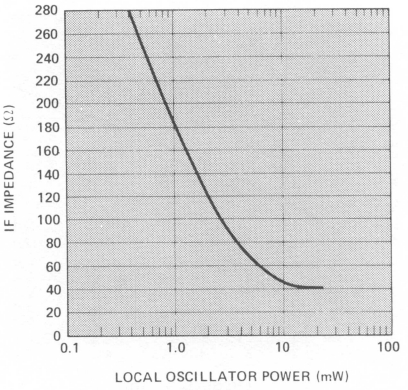


Figure 10. Typical HP 5082-2300 and 2400 Series IF Impedance vs. Local Oscillator Power with f_{LO} = 2.0 GHz and IF = 30 MHz. (The Mount is tuned for Minimum Noise Figure at each LO Level).

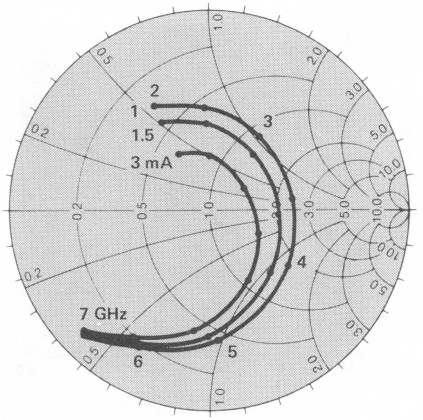


Figure 11. Typical Admittance Characteristics, 5082-2350 with Self Bias.

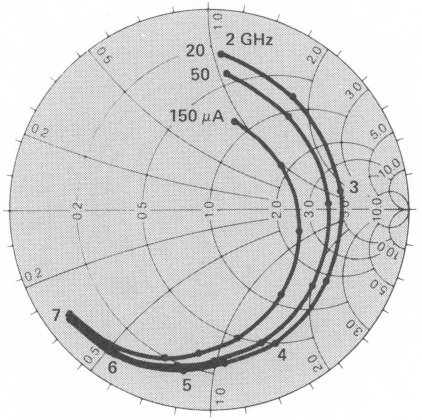


Figure 12. Typical Admittance Characteristics, 5082-2350 with External Bias.

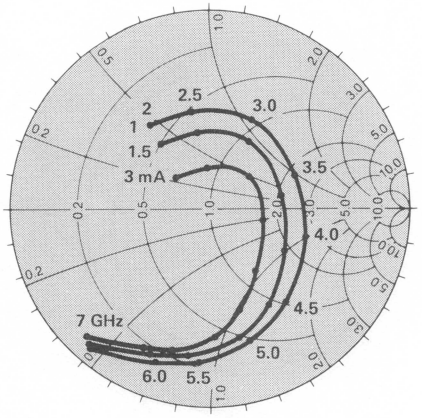


Figure 13. Typical Admittance Characteristics, 5082-2565 with Self Bias.

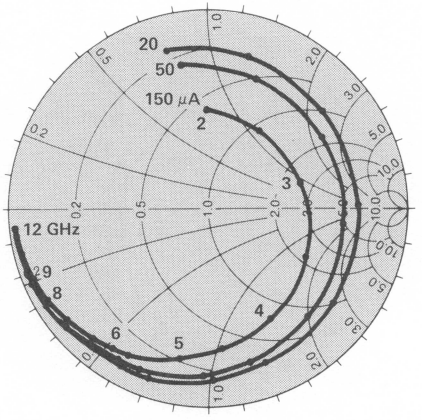


Figure 14. Typical Admittance Characteristics, 5082-2565 with External Bias.

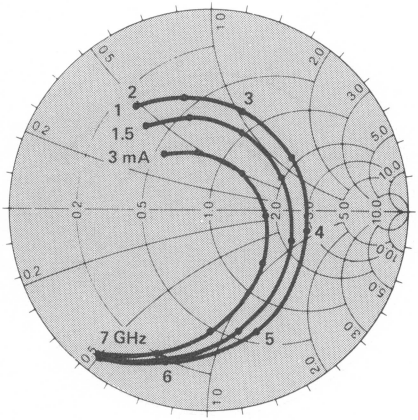


Figure 15. Typical Admittance Characteristics, 5082-2520 with Self Bias.

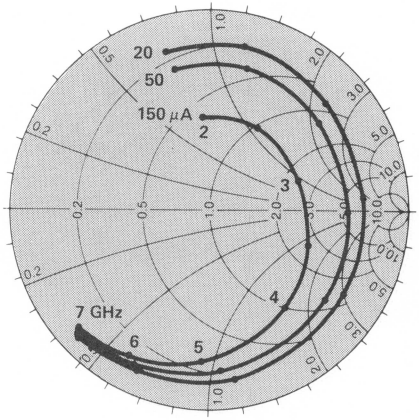


Figure 16. Typical Admittance Characteristics, 5082-2520 with External Bias.

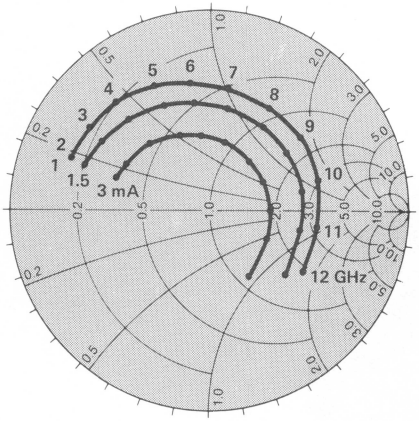


Figure 17. Typical Admittance Characteristics, 5082-2713 with Self Bias.

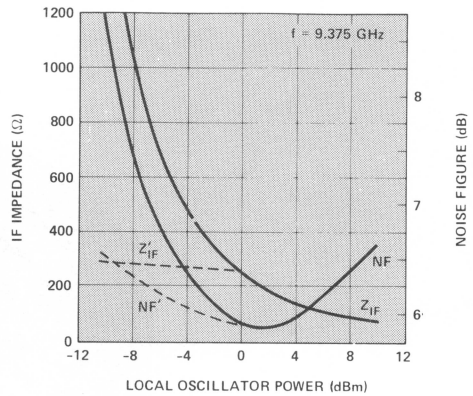


Figure 18. Typical Noise Figure and IF Impedance for 5082-2711 vs. Local Oscillator Power. Note the improved performance at low levels of LO power when dc bias is superimposed (dashed curves). (The Mount is tuned for Minimum Noise Figure at each LO Level).

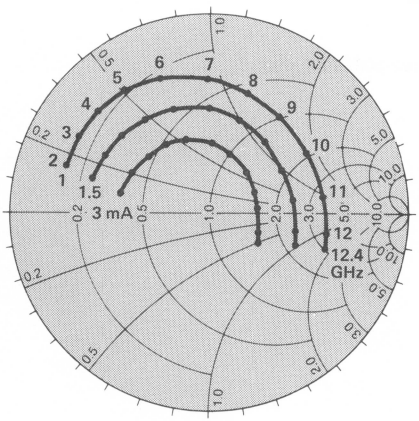


Figure 19. Typical Admittance Characteristics, 5082-2711 with Self Bias.

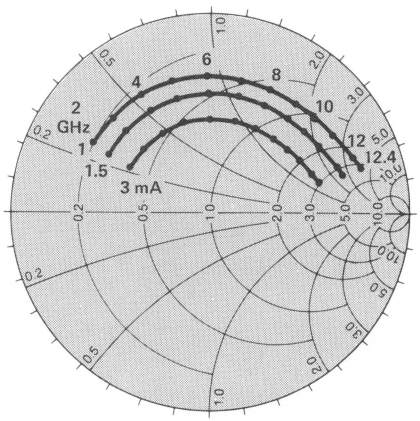


Figure 20. Typical Admittance Characteristics, 5082-2701 with Self Bias.

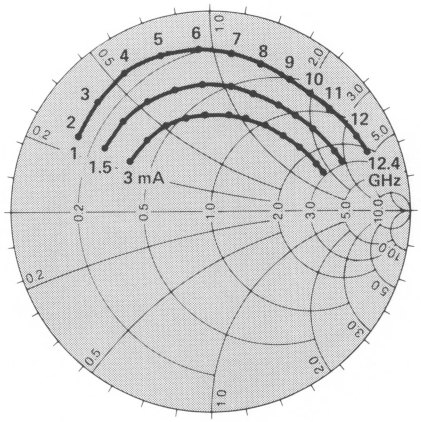


Figure 21. Typical Admittance Characteristics, 5082-2702 with Self Bias.

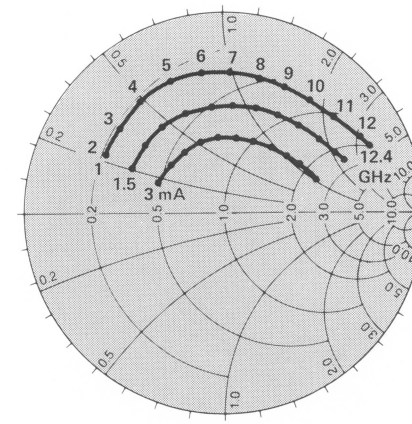


Figure 22. Typical Admittance Characteristics, 5082-2295 with Self Bias.

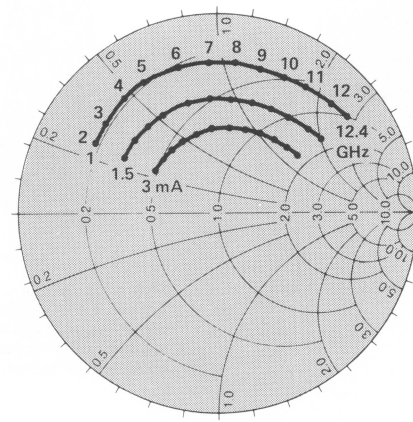


Figure 23. Typical Admittance Characteristics, 5082-2297 with Self Bias.

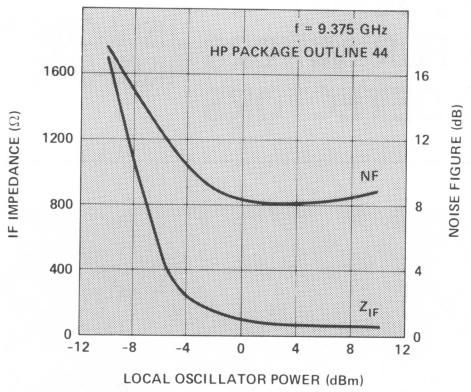


Figure 24. Typical Noise Figure and IF Impedance vs. Local Oscillator Power, 5082-2295 through -2298. Diode unmatched in 50 Ω line..

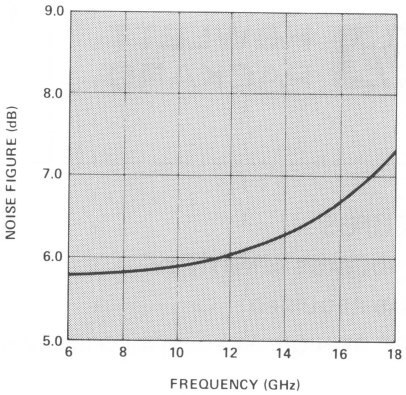


Figure 25. Typical Noise Figure vs. Frequency. IF = 30 MHz, NF_{IF} = 1.5 dB, P_{LO} = 1 mW. Diode tuned at each frequency (5082-2200, -2700 series).

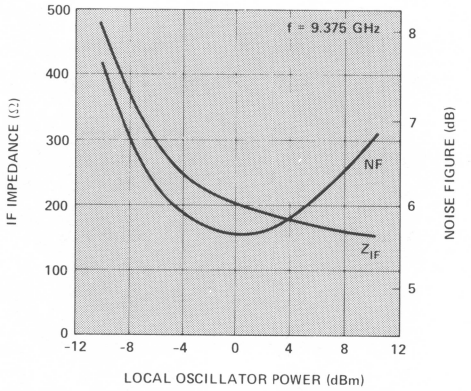


Figure 26. Typical Noise Figure and IF Impedance vs. Local Oscillator Power. Diode tuned at each local oscillator power level (5082-2295).

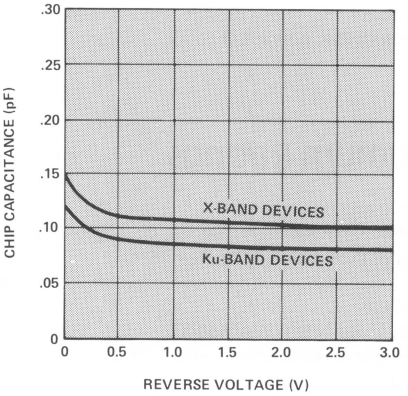


Figure 27. Typical Chip Capacitance vs. Reverse Voltage (5082-2200, -2700 Series).

HEWLETT PACKARD

ZERO BIAS SCHOTTKY DIODES FOR MIXERS AND DETECTORS

HSCH-3206/07
HSCH-3486

Features

HIGH VOLTAGE SENSITIVITY

NO BIAS REQUIRED

CHOICE OF HIGH OR LOW VIDEO IMPEDANCE

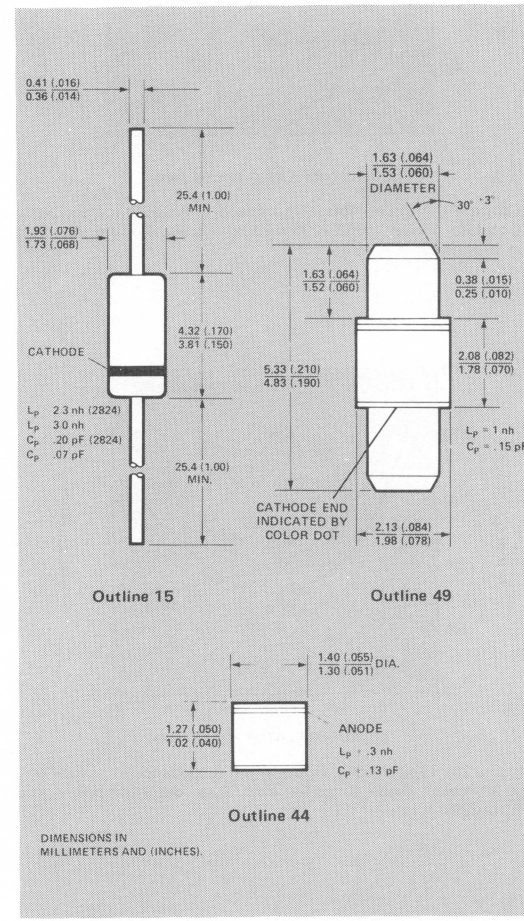
Description/Applications

The high zero bias voltage sensitivity of these Schottky Barrier diodes makes them ideally suitable for narrow bandwidth video detectors, ECM receivers, and measurement equipment. These diodes also make excellent mixers for use with low power LO.

Maximum Ratings

Operating and Storage
Temperature Range ..... −65° C to +150° C
CW Power Dissipation at T_{CASE} = 25° C
HSCH-3206, -3207 ..... 200 mW
HSCH-3486 ..... 300 mW
Derate Linearly to 0 W at 150° C
Pulse Power Dissipation at T_{CASE} = 25° C.
Peak power incident.
1 μs pulse, Du = 0.001 ..... 1 W

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.



Package Characteristics

The HP Outline 15 package has a glass hermetic seal with gold plated Dumet leads which should be restricted so that the bend starts at least 1/16" (1.6 mm) from the glass body. With this restriction, it will meet MIL-STD-750, Method 2036, Conditions A and E (4 lb. [1.8 kg] tension for 30 minutes). The maximum soldering temperature is 230° C for 5 seconds. Marking is by digital coding with a cathode band.

The HP Outline 49 package has a metal-ceramic hermetic seal. The anode and cathode studs are gold-plated Kovar. The maximum soldering temperature is 230° C for 5 seconds. Stud-stud T/R is 0.010" max.

The HP Outline 44 package is a hermetically sealed ceramic package. The anode and cathode are gold-plated Kovar. The maximum soldering temperature is 230° C for 5 seconds.

Electrical Specifications at T_A=25°C

Part Number	Package Outline	Maximum Tangential Sensitivity TSS (dBm)	Minimum Voltage Sensitivity γ (mV/μW)	Video Resistance R_V (KΩ) Min.	Max.	Typical Total Capacitance C_T (pF)
HSCH-3207	44	-42	8	80	300	0.30
HSCH-3206	49	-42	10	100	300	0.30
HSCH-3486	15	-54	7.5	2	8	0.30
Test Conditions		Video Bandwidth = 2 MHz f_{test} = 10 GHz	Power in = -40 dBm f_{test} = 10 GHz			V_R = 0 V f = 1 MHz

Note:
For HSCH-3207, -3206, I_R = 10 μA (max) at V_R = 3 V at T_A = 25° C. For reverse characteristics of HSCH-3486 see Figure 3.

Typical Characteristics

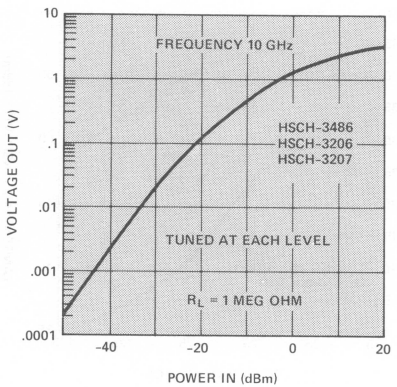


Figure 1. Typical Dynamic Transfer Characteristics.

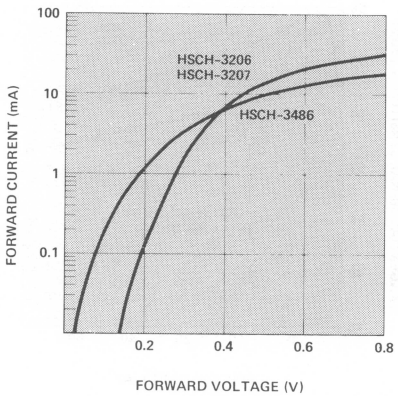


Figure 2. Typical Forward Characteristics at T_A = 25°C.

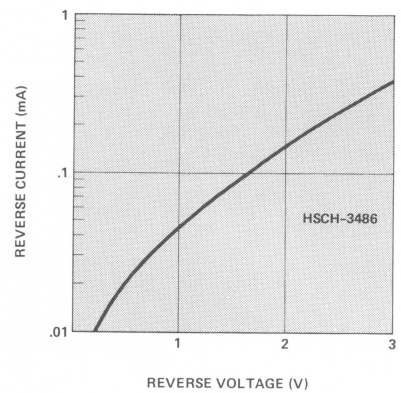


Figure 3. Typical Reverse Characteristics at T_A = 25°C.

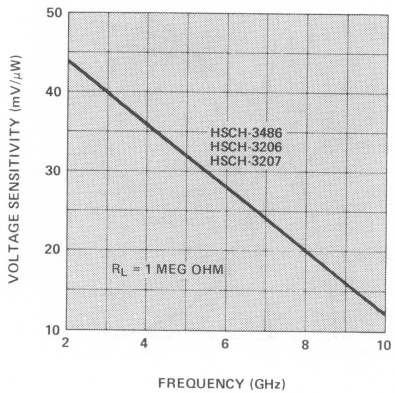


Figure 4. Typical Voltage Sensitivity vs. Frequency.

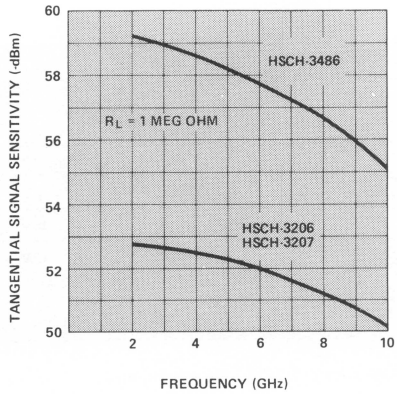


Figure 5. Typical Tangential Sensitivity vs. Frequency.

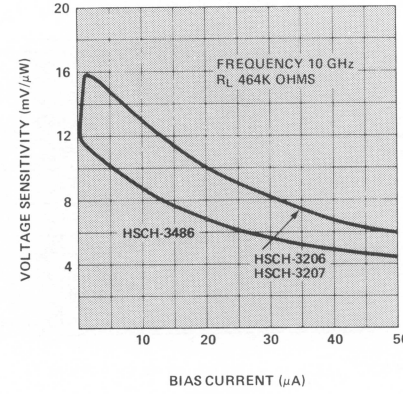


Figure 6. Typical Voltage Sensitivity vs. Bias Current.

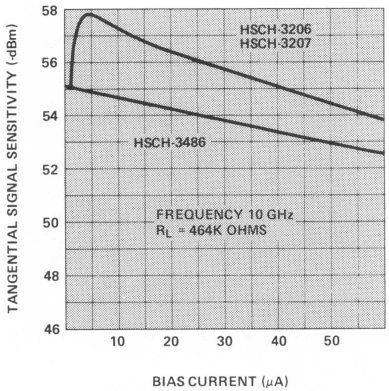


Figure 7. Typical Tangential Sensitivity vs. Bias Current.

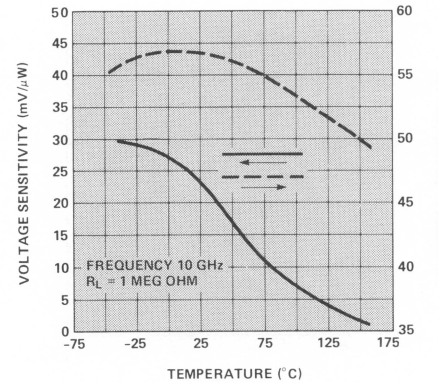


Figure 8. Effect of Temperature on HSCH-3486.

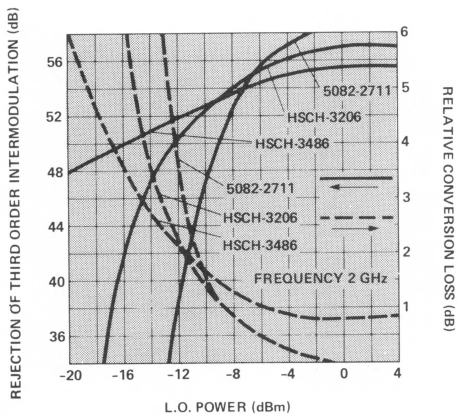


Figure 9. Mixer Performance.

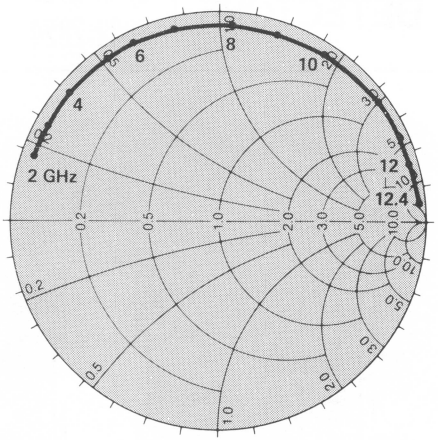


Figure 10. Typical Admittance Characteristics, HSCH-3206.

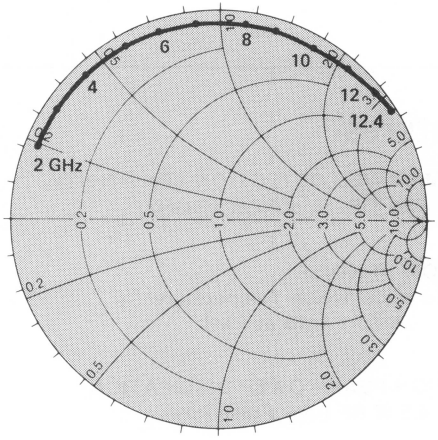


Figure 11. Typical Admittance Characteristics, HSCH-3207.

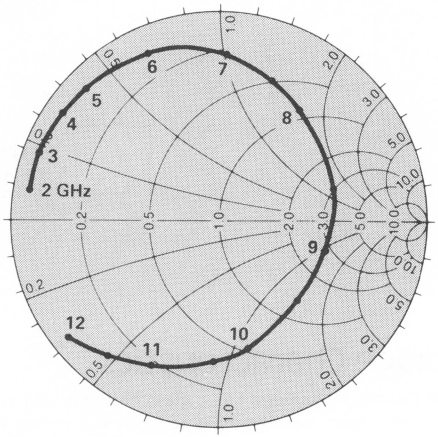


Figure 12. Typical Admittance Characteristics, HSCH-3486.

HEWLETT PACKARD

SCHOTTKY BARRIER DIODES FOR DETECTORS

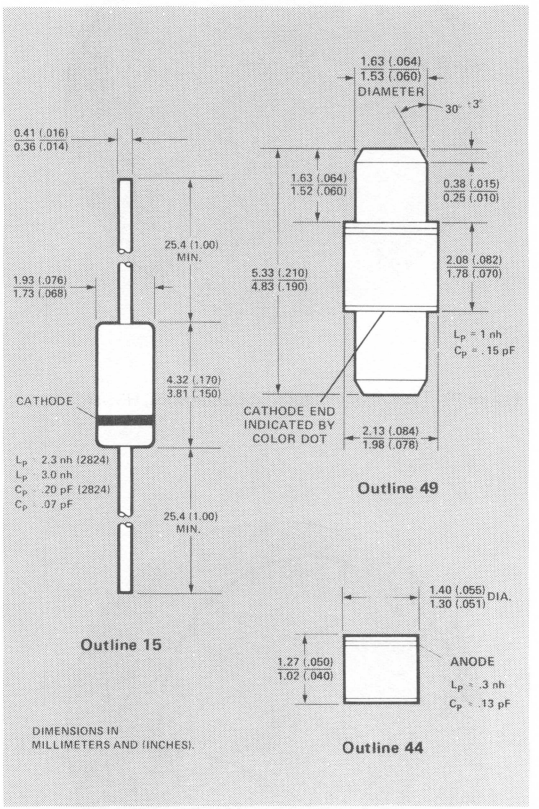
5082-2750/51
5082-2755
5082-2787
5082-2824

Features

IMPROVED DETECTION SENSITIVITY
TSS OF -55 dBm at 10 GHz

LOW 1/f NOISE
Typical Noise-Temperature Ratio = 4 dB at 1 kHz

HIGH PEAK POWER DISSIPATION
4.5 W RF Peak Pulse Power



Description / Applications

The low 1/f noise and high voltage sensitivity make these Schottky barrier diodes ideally suitable for narrow bandwidth video detectors, and Doppler mixers as required in Doppler radar equipment, ECM receivers, and measurement equipment.

Maximum Ratings

Junction Operating and Storage Temperature Range
5082-2824 ..... -65°C to +200°C
All Others ..... -60°C to +150°C

DC Power Dissipation — Power Absorbed by Diode
Derate Linearly to zero at Maximum Temperature
5082-2824 ..... 250 mW
All Others ..... 100 mW

Soldering Temperature ..... 230°C for 5 sec.

RF Peak Pulse Power at T_{CASE} = 25°C (Pulse Width = 1 μs, Du = 0.001)
5082-2824 (Power Absorbed by Diode) ..... 4.5 W
All Others (Power Incident) ..... 2.0 W

Maximum Peak Inverse Voltage (PIV) ..... V_{BR}

Note: The 2700 series diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Package Characteristics

The HP Outline 15 package has a glass hermetic seal with plated Dumet leads which should be restricted so that the bend starts at least 1.16" (1.6 mm) from the glass body. With this restriction, it will meet MIL-STD-750, Method 2036, Conditions A and E (4 lb. [1.8 kg] tension for 30 minutes). The maximum soldering temperature is 230°C for 5 seconds. Marking is by digital coding with a cathode band.

The HP Outline 49 package has a metal-ceramic hermetic seal. The anode and cathode studs are gold-plated Kovar. The maximum soldering temperature is 230°C for 5 seconds. Stud-stud T/R is 0.010" max.

The HP Outline 44 package is a hermetically sealed ceramic package. The anode and cathode are gold-plated Kovar. The maximum soldering temperature is 230°C for 5 seconds.

Electrical Specifications at T_A=25°C

Part Number 5082-	Package Outline	Maximum Tangential Sensitivity TSS (dBm)	Voltage Sensitivity Minimum γ (mV/μW)	Video Resistance R_V (kΩ) Min.	Video Resistance R_V (kΩ) Max.	Minimum Breakdown Voltage V_{BR} (V)
2824	15	-56	6.0	1.2	1.5	15
2787*		-52	3.5		1.8	4
2755		-55	5		1.6	
2751	49					
2750	44					
Test Conditions		Video Bandwidth = 2 MHz f_{RF} = 2 GHz for 5082-2824, 10 GHz for all others I_{BIAS} = 20 μA; Video Amp. Eq. Noise, R_A = 500Ω.	Same as for TSS at RF Signal Power Level of -40 dBm. Load Resistance = 100kΩ			I_R = 10 μA

Typical Parameters

Noise Temperature Ratio at f (dB)	Junction Capacitance C_{JO} (pF)
2 at 20 kHz 8 at 1 kHz	1.0
	.12
5.0 at 20 kHz 15.0 at 1 kHz	.1
R_V = 50Ω	V = 0

*RF Parameters for the 5082-2787 are sample tested only.

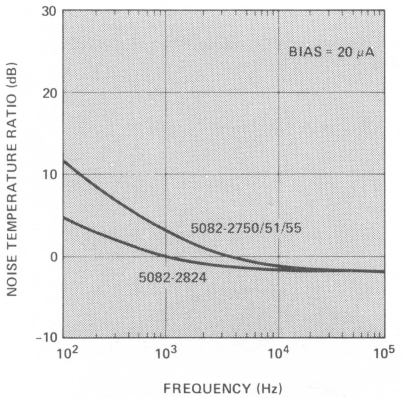


Figure 1. Typical Flicker (1/f) Noise vs. Frequency.

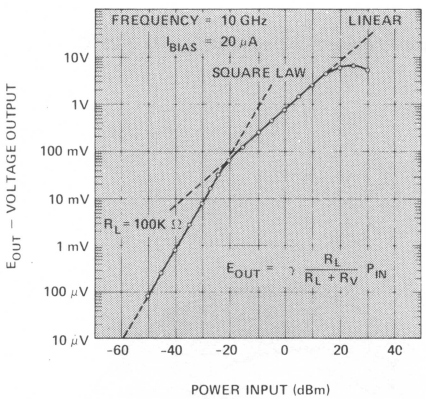


Figure 2. Typical Dynamic Transfer Characteristic. (5082-2750 Series).

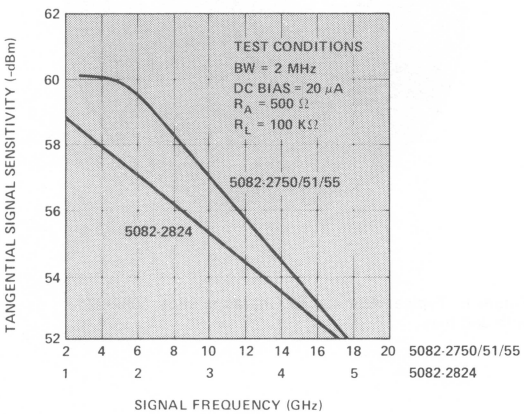


Figure 3. Typical TSS vs. Frequency.

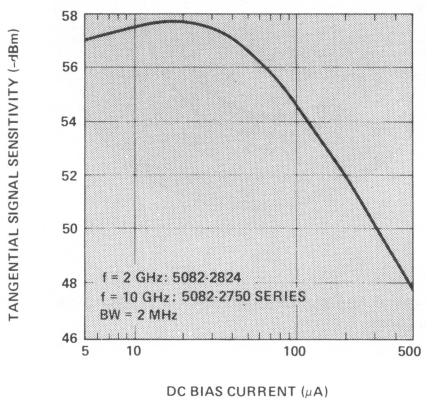


Figure 4. Typical TSS vs. Bias.

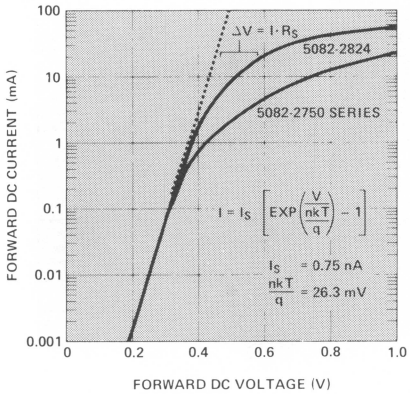


Figure 5. Typical Forward Characteristics at $T_A = 25°C$.

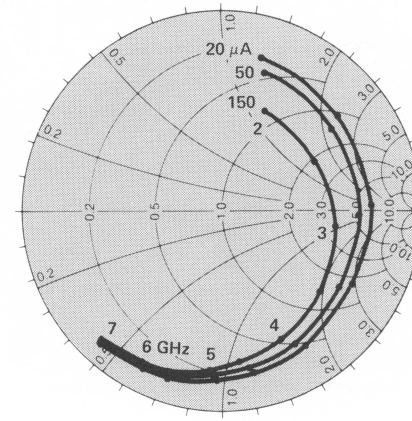


Figure 6. Typical Admittance Characteristics, 5082-2824 with external bias.

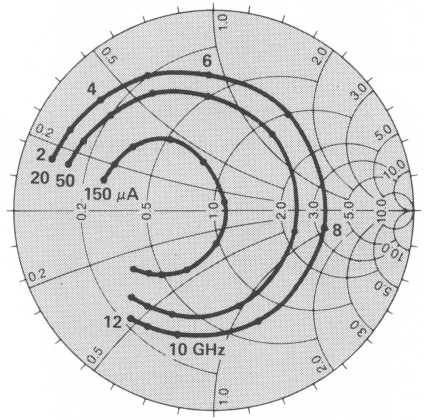


Figure 7. Typical Admittance Characteristics, 5082-2755 with external bias.

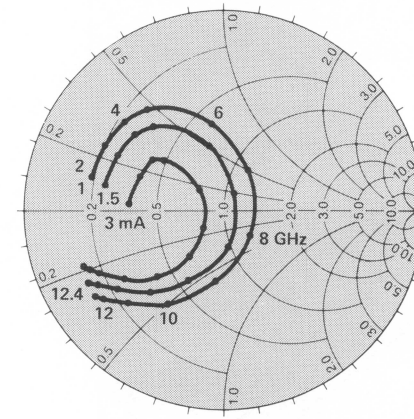


Figure 8. Typical Admittance Characteristics, 5082-2755 with self bias.

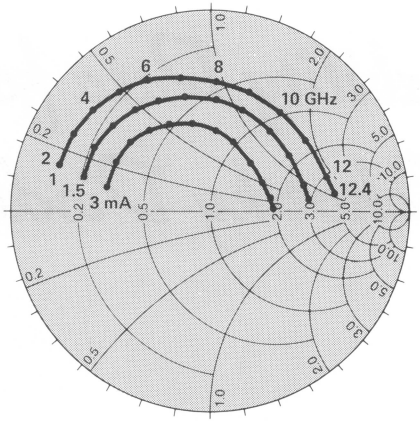


Figure 9. Typical Admittance Characteristics, 5082-2751 with self bias.

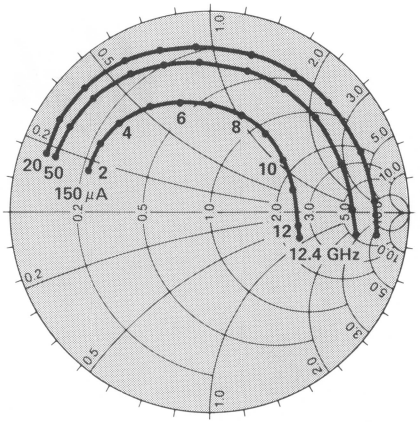


Figure 10. Typical Admittance Characteristics, 5082-2751 with external bias.

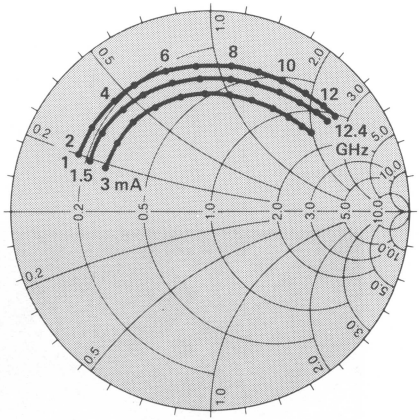


Figure 11. Typical Admittance Characteristics, 5082-2750 with self bias.

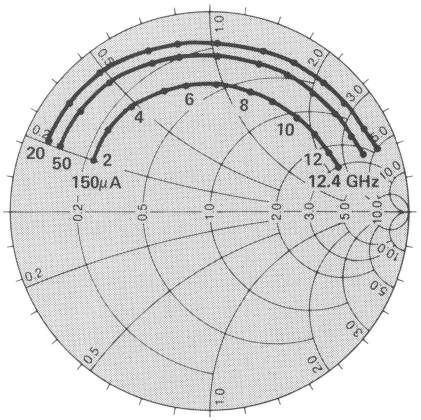
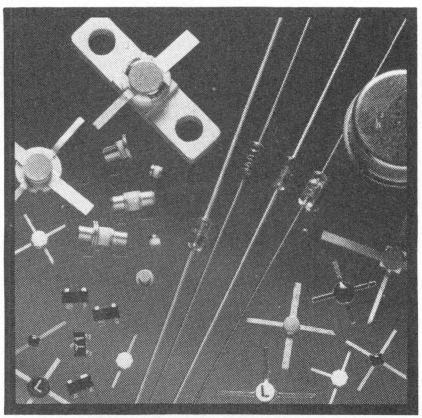


Figure 12. Typical Admittance Characteristics, 5082-2750 with external bias.

High Reliability Data for Schottky Diodes



HEWLETT PACKARD

HIGH RELIABILITY SCHOTTKY CHIP FOR MEDICAL APPLICATIONS (Generic 5082-0094)

HSCH-1111

Features

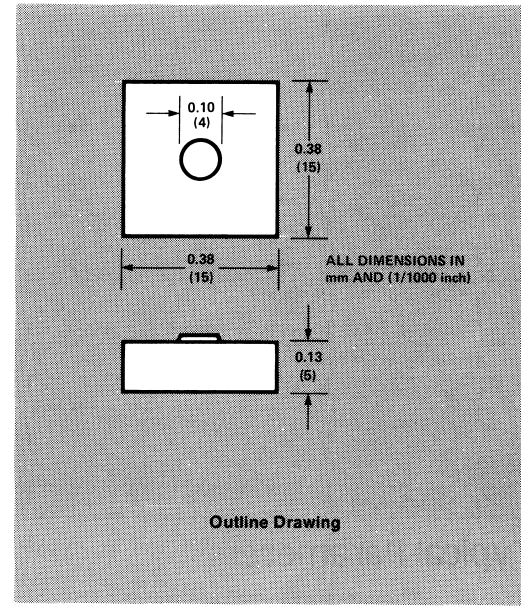
JAN-TXV EQUIVALENT

HIGH BREAKDOWN VOLTAGE

PICO-SECOND SWITCHING SPEED

LOW TURN-ON

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500



Outline Drawing

Program Description

Medical life support equipment requires highly reliable components. To meet that requirement, Hewlett-Packard's policy is to supply only components which have been tested in the equivalent of a JAN-TXV program.

The components and documentation supplied conform to the present requirements imposed by the Food and Drug Administration regulations concerning medical devices. It will be standard practice for all orders of life support application components to: (1) be shipped with a statement confirming release to ship by the Product Assurance Department, (2) be provided with traceability of the testing done, and (3) be packaged so they can go into customer stock with minimum handling.

The reliability tests possible for components supplied in chip form are inadequate to condition and screen them thoroughly. The customer must rely on the screening tests he performs on his finished device in order to eliminate chips that are subject to early life failure. To provide the highest confidence that the screening tests on the finished device will be successful, HP will conduct JAN-TXV type qualification tests on packaged samples from the lot of chips and ship only from accepted lots. Qualification data are available upon request.

Maximum Ratings

Operating and Storage Temperature Range ..... -65° C to 200° C

Reverse Voltage (Working) ..... 50 V (peak)

Power Dissipation at $T_{HEAT\ SINK}$ = 25° C ..... 250 mW
(Derate Linearly at 1.43mW/° C to Zero at 200° C)

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C (Similar to 5082-0094)

Specification	Symbol	Min.	Max.	Units	Test Condition
Breakdown Voltage	V_{BR}	70	—	V	I_R = 10 μA
Forward Voltage	V_{F1}	—	.41	V	I_{F1} = 1 mA
Forward Voltage	V_{F2}	—	1.0	V	I_{F2} = 15 mA
Reverse Leakage Current	I_R	—	50	nA	V_R = 50 V
Capacitance	$C_{J(o)}$	—	1.7	pF	V_R = 0 V and f = 1 MHz

TABLE II. 100% INSPECTION FOR HSCH-1111 SCHOTTKY CHIPS

Inspection	MIL-STD-750 Method	Conditions
1. Electrical Test (Die Probe) V_{BR}, V_{F1}, I_R, $C_{j(o)}$	—	Per Table I.
2. Visual Inspection	2073	

TABLE III. WAFER LOT ACCEPTANCE TEST FOR HSCH-1111

Test/Inspection	MIL-STD-750 Method (except as noted)	Conditions	LTPD
1. Bond Strength	MIL-STD-883 Method 2011, Cond. D	Condition A, n = 11, r = 1	20
2. Die Shear Strength (48 hrs. bake at 200° C prior to this test).	MIL-STD-883 Method 2019	n = 11, r = 1	20
3. Assembly in Suitable Carriers	—	—	
4. Electrical Test (Go/No Go)	—	—	
5. Thermal Shock (Temperature Cycling)	1051		
6. Constant Acceleration	2006	20 KG at Y_1	
7. Interim Electrical Test (V_F, V_{BR}, I_R, C_J)		Per Table I	
8. High Temperature Life (Non-Operating)	1032	t = 340 Hours at 200° C	10
9. Interim Electrical Test	—	Per Table I	
10. Operating Life	1027	Condition B, I_O = 33 mA, V_{RM} = 50 V, f = 60 Hz, T_A = 25° C, t = 340 hrs.	10
11. Final Electrical Test	—	Per Table I	

Typical Parameters

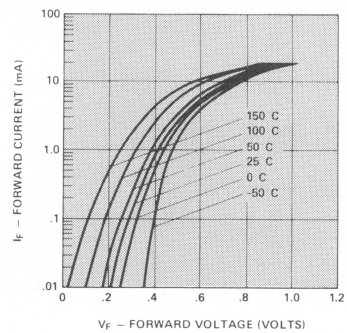


Figure 1.

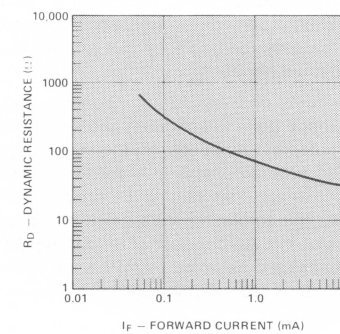


Figure 2.

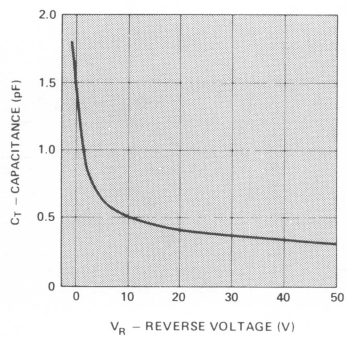


Figure 3.

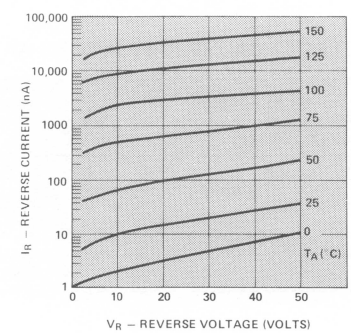


Figure 4.

HEWLETT PACKARD

HIGH RELIABILITY BEAM LEAD SCHOTTKY DIODES FOR MIXERS AND DETECTORS

TXVW-5300 SERIES

Features

PLATINUM TRI-METAL SYSTEM
Higher Temperature

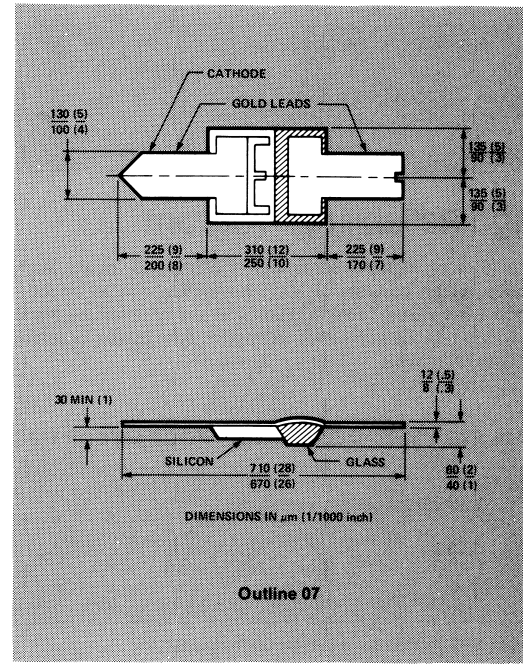
NITRIDE PASSIVATION
Stable, Reliable Performance

LOW NOISE FIGURE
6 dB Typical at 9 GHz

HIGH UNIFORMITY
Tightly Controlled Process Insures Uniform RF Characteristics

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500



Outline 07

Description/Applications

This family consists of medium and low barrier microwave Schottky diodes available as hybrid beam leads or mounted in easily handled carrier packages. Hewlett-Packard has developed a cost effective standard test program designed to screen these microwave Schottky diodes for applications requiring high-reliability performance.

TABLE I. ELECTRICAL SPECIFICATIONS FOR RF TESTED DIODES AT $T_A = 25°C$

Part Number HSCH-	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	IF Impedance Z_{IF} (Ω) Max.	Maximum SWR	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Maximum Total Capacitance C_T (pF)	Maximum Leakage Current I_R (nA)	Typical Forward Voltage V_F (mV)
5318	Medium	6.2 at 9.375 GHz	200	400	1.5:1	4	12	0.25	500	450
5314		7.2 at 16 GHz					18	0.15		
5320		7.5 at 26 GHz					20	0.10		
5338	Low	6.2 at 9.375 GHz	150	350	1.5:1	4	12	0.25	500	300
5334		7.2 at 16 GHz					18	0.15		
5340		7.5 at 26 GHz					20	0.10		
Test Conditions		DC Load Resistance = 0 Ω LO Power = 1 mW I_F = 30 MHz, 1.5 dB NF				I_R = 10 μ	I_F = 5 mA	V_R = 0 V f = 1 MHz	V_R = 1 V	I_F = 1 mA

Note: Similar HP beam lead products are available for Hi-Rel programs. See page 4-18.

ELECTRICAL SPECIFICATIONS FOR DC TESTED DIODES AT $T_A = 25°C$

Part Number HSCH-	Barrier	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Maximum Total Capacitance C_T (pF)	Typical Forward Voltage V_F (mV)
5316	Medium	4	12	0.25	450
5312			18	0.15	
5310			25	0.10	
5336	Low	4	12	0.25	300
5332			18	0.15	
5330			25	0.10	
Test Conditions		$I_R = 10\ \mu A$	$I_F = 5$ mA	$V_R = 0$ V, f = 1 MHz	$I_F = 1$ mA

High Reliability Program

One level of high rel screening is offered for beam lead diodes, which consists of 100% inspection and lot acceptance testing (See Table II). Tables III and IV detail the tests performed. Diodes screened to this program can be ordered as TXVW-53XX.

TABLE II. HIGH RELIABILITY TEST LEVELS

Beam Lead[1]	Inspection Level
HSCH-53XX	Commercial
TXVW-53XX	100% Inspection, visual, and lot acceptance test

Note 1: Beam Leads: Entire HSCH-5300 Series.

TABLE III. 100% INSPECTION PROGRAM FOR HSCH-5300 SERIES BEAM LEADS (OUTLINE 07)

Screening Test/Inspection	MIL-STD-750 Method	Conditions
1. High Temperature Storage (Stabilization Bake)	—	24 hours at 300° C
2. Electrical Test (Die Probe) V_F, I_R, C_J	—	Per Table I
3. Visual Inspection	HP A5956-0112-72[1]	High Reliability Visual

Notes: 1. Specification available upon request.

TABLE IV. LOT ACCEPTANCE TEST FOR HSCH-5300 SERIES BEAM LEADS (OUTLINE 07)

Test/Inspection	MIL-STD-750 Method (except as noted)	Conditions	LTPD
1. Beam Pull Test	MIL-STD-883 Method 2011 Cond. H	Condition H (4 grams min.), n = 11, r = 1	20
2. Assemble Samples in Suitable Carrier	—	—	
3. Electrical Test (Go/No Go) V_{BR}, I_R, V_F, C_T	—	Per Table I	
4. Temperature Cycle	1051	F - 10 cycles 15 min. at extremes -65° to 200° C	
5. Interim Electrical Test	—	Read and record	
6. High Temperature Life (Non-Operating)	1032	340 hours at 200° C	10
7. High Temperature Reverse Bias (HTRB)	1038	$V_R = 1.0$ V dC, $T_A = 150°$ C, t = 340 hours	
8. Interim Electrical Test (I_R, V_F, C_T)	—	Per Table I	
9. Operating Life	1027	$I_O = 10$ mA DC, $T_A = 125°$ C, t = 340 hours	10
10. Final Electrical Test (I_R, V_F, C_T)	—	Per Table I	

HEWLETT PACKARD

HIGH RELIABILITY BEAM LEAD SCHOTTKY DIODE PAIRS FOR MIXERS AND DETECTORS

TXVW-5500 SERIES

Features

MONOLITHIC PAIR
Closely Matched Electrical Parameters

LOW CAPACITANCE
0.10 pF Max. at 0 Volts

LOW NOISE FIGURE
7.0 dB at 16 GHz

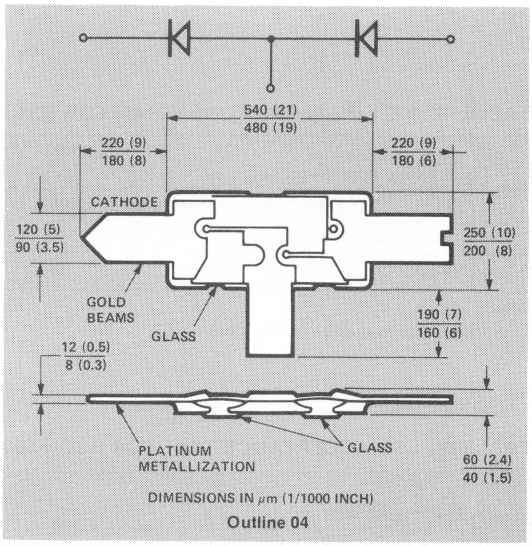
RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

PLATINUM TRI-METAL SYSTEM
High Temperature

POLYIMIDE SCRATCH PROTECTION

NITRIDE PASSIVATION
Stable, Reliable Performance

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500



Outline 04

Description/Applications

This family consists of medium and low barrier microwave Schottky diodes available as hybrid beam leads or mounted in easily handled carrier packages. Hewlett-Packard has developed a cost effective standard test program designed to screen these microwave Schottky diodes for applications requiring high-reliability performance.

TABLE I. ELECTRICAL SPECIFICATIONS FOR RF TESTED DIODES AT $T_A = 25°C$

Part Number HSCH-	Barrier	Maximum Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	IF Impedance Z_{IF} (Ω) Max.	Maximum SWR	Minimum Breakdown Voltage V_{BR} (V)	Maximum Dynamic Resistance R_D (Ω)	Max. ΔR_D (Ω)	Maximum Total Capacitance C_T (pF)	Max. ΔC_T (pF)	Maximum Forward Voltage V_F (mV)	Max. ΔV_F (mV)
5520	Medium	7.5 at 26 GHz	200	400	1.5:1	4	20	3	0.10	0.02	500	10
5510		7.0 at 16 GHz					20	3	0.10			
5518		7.2 at 16 GHz					16	2	0.15	0.03		
5514		6.2 at 9.375 GHz					12		0.25			
5540	Low	7.5 at 26 GHz	150	350			20	3	0.10	0.02	375	
5530		7.0 at 16 GHz					20	3	0.10			
5538		7.2 at 16 GHz					16	2	0.15	0.03		
5534		6.2 at 9.375 GHz					12		0.25			
Test Conditions		DC Load Resistance = 0 Ω L.O. Power = 1 mW I_F = 30 MHz, 1.5 dB NF				I_R = 10 μA	I_F = 5 mA		V_R = 0 V f = 1 MHz		I_F = 1 mA	
						Measured across adjacent leads						

Note: Similar HP beam lead products are available for Hi-Rel programs. See page 4-25.

High Reliability Program

One level of high rel screening is offered for beam lead diodes, which consists of 100% inspection and lot acceptance testing (see Table II). Tables III and IV detail the tests performed. Diodes screened to this program can be ordered as TXVW-55XX.

TABLE II. HIGH RELIABILITY TEST LEVELS

Beam Lead[1]	Inspection Level
HSCH-55XX	Commercial
TXVW-55XX	100% Inspection, visual, and lot acceptance test

Note:
1. Beam Leads: Entire HSCH-5500 series.

TABLE III. 100% INSPECTION PROGRAM FOR HSCH-5500 SERIES BEAM LEADS (OUTLINE 04)

Screening Test/Inspection	MIL-STD-750 Method	Conditions
1. High Temperature Storage (Stabilization Bake)	—	24 hours at 300° C
2. Electrical Test (Die Probe)	—	Per Table I
3. Visual Inspection	HP A5956-0112-72[1]	High Reliability Visual

Note:
1. Specification available upon request.

TABLE IV. LOT ACCEPTANCE TEST FOR HSCH-5500 SERIES BEAM LEADS (OUTLINE 04)

Test/Inspection	MIL-STD-750 Method (except as noted)	Conditions	LTPD
1. Beam Pull Test	MIL-STD-883 Method 2011 Cond. H	Condition H (4 grams min.) n = 11, r = 1	20
2. Assemble Samples in Suitable Carrier	—	—	
3. Electrical Test (Go/No Go)	—	Per Table I	
4. Temperature Cycle	1051	F - 10 cycles 15 min. at extremes -65° to 200° C	
5. Interim Electrical Test (I_R, V_F, C_T)	—	Per Table I	
6. High Temperature Life (Non-Operating)	1032	340 hours at 200° C	10
7. High Temperature Reverse Bias (HTRB)	1038	V_R = 1.0 V dC T_A = 150° C, t = 340 hours	
8. Interim Electrical Test (I_R, V_F, C_T)	—	Per Table I	
9. Operating Life	1027	I_O = 10 mA DC T_A = 125° C, t = 340 hours	10
10. Final Electrical Test (I_R, V_F, C_T)	—	Per Table I	

HEWLETT PACKARD

BEAM LEAD SCHOTTKY DIODE QUADS FOR DOUBLE BALANCED MIXERS OPERATING TO 26 GHz

TXVW-5800 SERIES

NEW

Features

MONOLITHIC RING QUADS
Closely Matched Electrical Parameters

LOW CAPACITANCE
0.10 pF Max. at 0 V

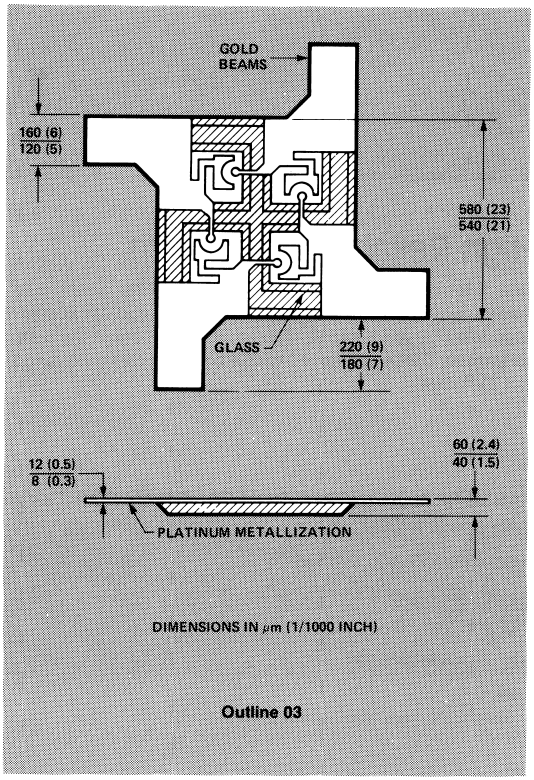
PLANAR SURFACE
Easier Bonding, Stronger Leads

PLATINUM TRI-METAL SYSTEM
High Temperature Stability

POLYIMIDE SCRATCH PROTECTION

SILICON NITRIDE PASSIVATION
Stable, Reliable Performance

QUALITY PERFORMANCE TESTED
Test Program Patterned After MIL-S-19500



Outline 03

Description

These beam lead diode quads are constructed using a metal-semiconductor Schottky barrier junction. Advanced epitaxial techniques and precise process control insure uniformity and repeatability of this planar passivated microwave semiconductor. A nitride passivation layer provides immunity from contaminants which could otherwise lead to I_R drift.

The family consists of medium and low barrier microwave Schottky diodes available as hybrid beam leads or mounted in easily handled carrier packages. Hewlett-Packard has developed a cost effective standard test program designed to screen these microwave Schottky diodes for applications requiring high-reliability performance.

Maximum Ratings

CW Power Dissipation at T_{LEAD} = 25°C ..... 150 mW
Derate linearly to zero at maximum rated temperature.

T_{OPR} — Operating Temperature Range ..... −65°C to +175°C

T_{STG} = Storage Temperature Range ..... −65°C to +200°C

Minimum Lead Strength ..... 4 grams pull on any lead

Diode Mounting Temperature ..... 350°C for 10 sec. max.

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

Applications

These diodes are designed for use in double balanced mixers, phase detectors, AM modulator, and digital modulators requiring wideband operation and small size. The outline geometries are designed to balance the internal lead inductance for optimal performance at higher frequencies. The monolithic construction results in inherently low parasitics and extremely tight uniformity. The low barrier diodes allow for optimum mixer noise figure at lower than conventional local oscillator level. The wider dynamic range of the medium barrier diodes allows for better distortion performance.

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C

Frequency Band	Part Number HSCH-	Barrier	Maximum Capacitance C_T (pF)		Maximum Adjacent Capacitance Difference $\triangle C_T$ (pF)	Maximum Dynamic Resistance R_D (Ω)	Maximum Resistance Difference $\triangle R_D$ (Ω)	Maximum Forward Voltage V_F (mV)	Maximum V_F Difference $\triangle V_F$ (mV)
			Diagonal	Adjacent					
X	5816	Medium	0.25	0.33	0.03	12	2	500	15
12 GHz	5836	Low						375	
Ku	5812	Medium	0.15	0.20		16		500	
18 GHz	5832	Low						375	
K	5810	Medium	0.10	0.13	0.02	20	3	500	
26 GHz	5830	Low						375	
Test Conditions			V_R = 0 V f = 1 MHz			I_F = 5 mA		I_F = 1 mA Measured between adjacent leads	

High Reliability Program

One level of high rel screening is offered for beam lead diodes, which consists of 100% inspection and lot acceptance testing (see Table II). Tables III and IV detail the tests performed. Diodes screened to this program can be ordered as TXVW-58XX.

TABLE II. HIGH RELIABILITY TEST LEVELS

Beam Lead[1]	Inspection Level
HSCH-58XX	Commercial
TXVW-58XX	100% inspection per Table III and lot acceptance test per Table IV.

Note:

1. Beam Leads: Entire HSCH-5800 series.

TABLE III. 100% INSPECTION PROGRAM FOR TXVW-5800 SERIES BEAM LEADS (OUTLINE 04)

Screening Test/Inspection	MIL-STD-750 Method	Conditions
1. High Temperature Storage (Stabilization Bake)	—	24 hours at 300° C
2. Electrical Test (Die Probe)	—	Per Table I
3. Visual Inspection	HP A5956-0112-72[1]	High Reliability Visual

Note:

1. Specification available upon request.

TABLE IV. LOT ACCEPTANCE TEST FOR TXVW-5800 SERIES BEAM LEADS (OUTLINE 04)

Test/Inspection	MIL-STD-750 Method (except as noted)	Conditions	LTPD
1. Beam Pull Test	MIL-STD-883 Method 2011 Cond. H	Condition H (4 grams min.) n = 11, r = 1	20
2. Assemble Samples in Suitable Carrier	—	—	
3. Electrical Test (Go/No Go)	—	Per Table I	
4. Temperature Cycle	1051	F-10 cycles 15 min. at extremes -65° to 200° C	
5. Interim Electrical Test (V_F, C_T)	—	Per Table I	
6. High Temperature Life (Non-Operating)	1032	340 hours at 200° C	10
7. Interim Electrical Test (V_F, C_T)	—	Per Table I	
8. Operating Life	1027	I_O = 10 mA AC T_A = 125° C, t = 340 hours	10
9. Final Electrical Test (V_F, C_T)	—	Per Table I	

HEWLETT PACKARD

HIGH RELIABILITY SCHOTTKY BARRIER DIODES FOR MIXERS AND DETECTORS

(Generic 5082-2301, -2306, -2400, -2401)

HSCH-0813
HSCH-0814
HSCH-0815
HSCH-0816

Features

LOW 1/F NOISE

LOW AND STABLE NOISE FIGURE

HIGH UNIFORMITY

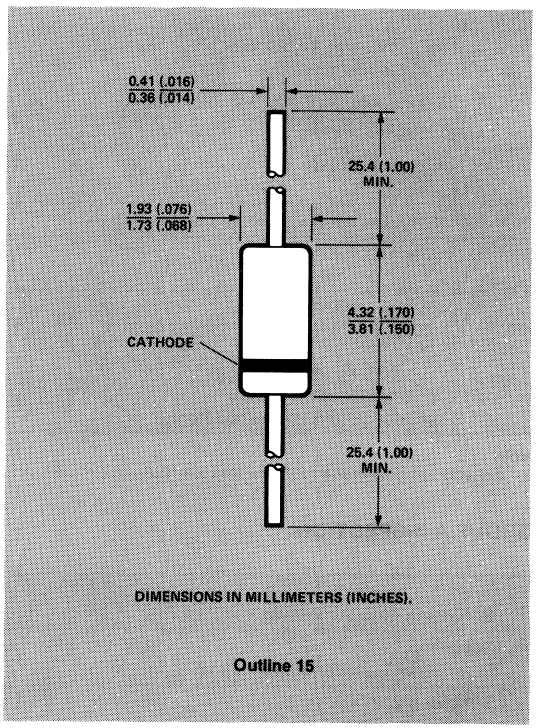
HIGH BREAKDOWN VOLTAGE: 30 VOLTS

MATCHED CHARACTERISTICS AVAILABLE

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

Description

The HSCH-0813, -0814, -0815, -0816 devices are unpassivated Schottky diodes in a glass package. These diodes have extremely low 1/f noise and are ideal for low noise mixing, and high sensitivity detecting. They are particularly well suited for use in Doppler or narrow band video receivers.



Maximum Ratings

Junction Operating and Storage Temperature Range ..... -60°C to +100°C

Power Dissipation at T_{CASE} = 25°C ..... 100 mW
Derate linearly at 1.33 mW/°C to zero at 100°C

TABLE I. ELECTRICAL SPECIFICATIONS FOR RF TESTED DIODE AT T_A = 25°C

(Similar to 5082-2400)

Part Number HSCH-	Matched Pair* HSCH-	Barrier	LO Test Frequency (GHz)	Maximum SSB Noise Figure NF (dB)	IF Impedance Z_{IF} (Ω) Min.	Max.	Maximum SWR	Maximum Capacitance C_T (pF)	Minimum Breakdown Voltage V_{BR} (V)
0814	0813	Medium	2.0	6.0	150	350	1.3:1	1.0	30
Test Conditions	$\Delta NF \leq 0.3$ dB $\Delta Z_{IF} \leq 25\Omega$		LO Power = 1 mW IF = 30 MHz, 1.5 dB NF Zero DC Load Resistance		Same as for NF except IF = 10 KHz		Same as for NF	V_R = 0V f = 1.0 MHz	I_R = 10 μA

*Match performed after 100% screening.

ELECTRICAL SPECIFICATIONS FOR DC TESTED DIODE AT T_A = 25°C

(Similar to 5082-2301)

Part Number HSCH-	Matched Pair* HSCH-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	V_F = 1V Max. at Forward Current I_F (mA)	Maximum Reverse Leakage Current I_R (nA) at V_R (V)	Maximum Capacitance C_T (pF)
0816	0815	30	400	50	300 at 15	1.0
Test Conditions	$\Delta V_F \leq 10$ mV $\Delta C_O \leq 0.2$ pF	I_R = 10 μA	I_F = 1 mA			V_R = 0 V f = 1.0 MHz

*Match performed after 100% screening.

High Reliability Conditioning and Lot Acceptance

(All test methods are per MIL-STD-750 unless otherwise specified)

100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual Inspection	—	Per H.P. Method A-5956-0562-72
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours., T_A = 100° C
3. Thermal Shock (Temperature Cycling)	1051	Condition B. -55° C to +100° C
4. Constant Acceleration	2006	20 KG. Y_1 axis.
5. Hermeticity Tests Fine Leak Gross Leak	1071	Condition H. Condition E.
6. Interim Electrical Tests (V_{BR}, I_R, V_F)		Per Table I. T_A = 25° C.
7. Burn-in	1038	P_{FM} = 75 mW, V_R = 15 V (pk) T_A = 25° C f = 60 Hz., t = 168 hours
8. Final Electrical Tests (V_{BR}, I_R, V_F)		Per Table I. T_A = 25° C
9. Drift Evaluation PDA = 10%[1]		ΔI_R = 200 nA or 100% whichever is greater. ΔV_F = ±50 mV.
10. Electrical Tests (NF, SWR) HSCH-0813 and HSCH-0814 only		

Note:
1. If rejects are greater than 10% but less than 20%, one more burn-in may be performed with a new 10% PDA.

GROUP A INSPECTION

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 External Visual and Mechanical	2071		5
Subgroup 2 Electrical Test (C_T)		Per Table I.	10
Subgroup 3 D.C. and RF Parameters at 25° C		Satisfied by 100% measurements at post burn-in.	

GROUP B INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Moisture Resistance End Points (V_{BR}, I_R, V_F)	1021	Omit initial conditioning Per Table I.	10
Subgroup 2 High Temperature Non Operating Life End Points (V_{BR}, I_R, V_F)	1031	T_A = 100° C, t = 1000 hours Per Table I.	10
Subgroup 3 Operating Life End Points (V_{BR}, I_R, V_F)	1026	P_{FM} = 75 mW, V_R = 15 V (peak), f = 60 Hz, T_A = 25° C, t = 1000 hours.	10

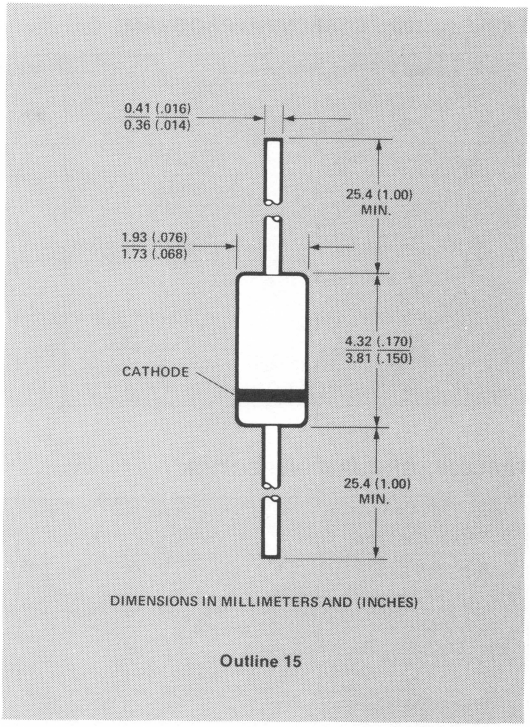
HEWLETT PACKARD

SCHOTTKY SWITCHING DIODE MILITARY APPROVED MIL-S-19500/444

JAN 1N5711
JANTX 1N5711
JANTXV 1N5711

Features

HIGH BREAKDOWN VOLTAGE
PICO-SECOND SWITCHING SPEED
LOW TURN-ON



Outline 15

Description/Applications

The JAN Series 1N5711 is an epitaxial, planar passivated Schottky Barrier Diode designed to have pico-second switching speed. These devices are well suited for high level detecting, mixing, switching, gating and converting, video detecting, frequency discriminating, sampling, and wave shaping applications that require the high reliability of a JAN/JANTX device.

Maximum Ratings

Operating and Storage Temperature Range ..... -65°C to 200°C
Reverse Voltage (Working) ..... 50 V (peak)
Power Dissipation at T_{CASE} = 25° C ..... 250 mW
Derate linearly at 1.43 mW/° C to zero at 200° C

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C (Unless otherwise specified)
(Per Table I, Group A Testing of MIL-S-19500/444)

Specification	Symbol	Min.	Max.	Units	Test Conditions
Breakdown Voltage	V_{BR}	70	—	V	I_R = 10μA
Forward Voltage	V_{F1}	—	.41	V	I_{F1} = 1mA
Forward Voltage	V_{F2}	—	1.0	V	I_{F2} = 15mA
Reverse Leakage Current	I_R	—	200	nA	V_R = 50V
Reverse Leakage Current	I_R	—	200	μA	V_R = 50V, T_A = +150°C
Capacitance	$C_{T(o)}$	—	2.0	pF	V_R = 0V and f = 1MHz
Effective Minority Carrier Lifetime	τ	—	100	pS	I_F = 5mA Krakauer Method [Note 1]

Note 1: Per DESC drawing C-68001

JAN 1N5711: Samples of each lot are subjected to Group A inspection for parameters listed in Table I, and to Group B and Group C tests listed below. All tests are to the conditions and limits specified by MIL-S-19500/444.

JANTX 1N5711: Devices undergo 100% screening tests as listed below to the conditions and limits specified by MIL-S-19500/444***. A sample of the JANTX lot is then subjected to Group A, Group B, and Group C tests as for the JAN 1N5711 above.

JANTXV 1N5711: Devices are subject to 100% visual inspection in accordance with MIL-S-19500/444 prior to being subjected to TX screening.

***JANTX and JANTXV devices have gold plated leads.

TABLE II. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 200° C
2. Thermal Shock (Temperature Cycling)	1051	Condition C, 10 Cycles
3. Centrifuge (Constant Acceleration)	2006	20 KG, Y_1 axis.
4. Hermeticity Tests Fine Leak Gross Leak	1071	Condition H. Condition C or E
5. Interim Electrical Tests (I_R, V_F)		See Table I
6. Burn-In	1038	I_O = 33 mA, V_R = 50 V (peak) T_A = 25° C, f = 60 Hz, T = 96 hours.
7. Final Electrical Tests and Drift Evaluation (I_R, V_{BR}) 10% PDA		$\Delta I_R \leq$ 50 nA or 100% whichever is greater $\Delta V_F = \pm$41 mV dc.

TABLE III. GROUP A INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Visual and Mechanical	2071		5
Subgroup 2			
Electrical Tests at 25° C	—	V_{BR}, V_{F1}, V_{F2}, I_{R1}, C_{TO} and r per Table I.	2
Subgroup 3			
High Temperature Operation (T_A = 150° C)	—		5
Reverse Currrent (I_{R2})		Per Table I.	

TABLE IV. GROUP B INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Physical Dimensions	2066		15
Subgroup 2			
Solderability	2026	Immerse to within 0.1 inch of body.	10
Thermal Shock (Temperature Cycling)	1051	Condition C, 10 Cycles	
Thermal Shock (Glass Strain)	1056	Condition A	
Terminal Strength (Tension)	2036	Condition A, 15 secs., 2 lbs.	
Hermetic Seal	1071	Condition E	
Moisture Resistance	1021	Omit initial conditioning	
End Points:			
Breakdown Voltage (V_{BR})	4021	Per Table I	
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4011	Per Table I	

TABLE IV. GROUP B INSPECTION (Cont.)

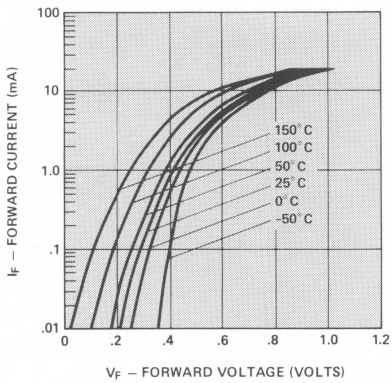
Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 3			
Shock	2016	Non-operating; 1500 G; t = 0.5 ms, 5 blows in each orientation X_1, Y_1, Y_2	10
Vibration Variable Frequency	2056	Non-operating	
Constant Acceleration	2006	Non-operating; 20 KG; X_1, Y_1, Y_2	
End Points: (same as Subgroup 2)			
Subgroup 4			
Terminal Strength; Lead Fatigue	2036	Condition E with lead restriction.	10
Subgroup 5			
High Temperature Life (Non-Operating)	1031	T_A = 200° C, [1]	$\lambda = 3$
End Points:			
Breakdown Voltage (V_{BR})	4021	63 V min. at 10 μA	
Forward Voltage (V_F)	4011	1.05 V max. at 15 mA	
Reverse Current (I_R)	4016	300 nA max. at 50 V	
Subgroup 6			
Steady State Operating Life	1026	I_O = 33 mA (avg.); V_R = 50 V (peak) f = 60 Hz, T_A = 25° C, [1]	$\lambda = 3$
End Points: (same as Subgroup 5)			

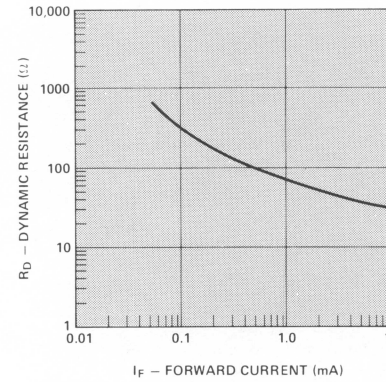
1. t = 1000 hours every 6 months to qualify product, t = 340 hours on each lot thereafter.

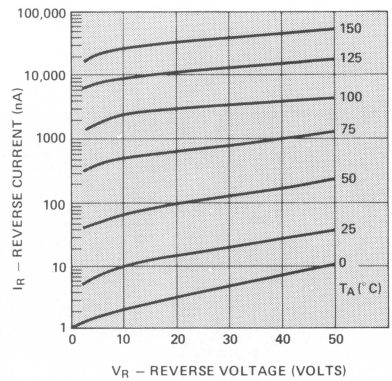
TABLE V. GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Salt Atmosphere (Corrosion)	1041		20
Subgroup 2			
Resistance to Solvents	MIL-STD-202 Method 215		10
Subgroup 3			
Thermal Shock (Temperature Cycling)	1051	Condition C. 25 cycles; time at temperature extremes = 15 minutes min. total test time = 72 hours max.	10
End Points:			
Breakdown Voltage (V_{BR})	4021	Per Table I	
Forward Voltage (V_{F2})	4011	Per Table I	
Reverse Current (I_{R1})	4016	Per Table I	
Subgroup 4			
Low Temperature Operation (−65° C)			20
Forward Voltage (V_{F1})		0.55 V at 1 mA	
Forward Voltage (V_{F2})		1.0 V at 15 mA	
Breakdown Voltage (V_{BR})		70 V at 10 μA	

Typical Parameters







HEWLETT PACKARD

SCHOTTKY SWITCHING DIODE MILITARY APPROVED MIL-S-19500/445

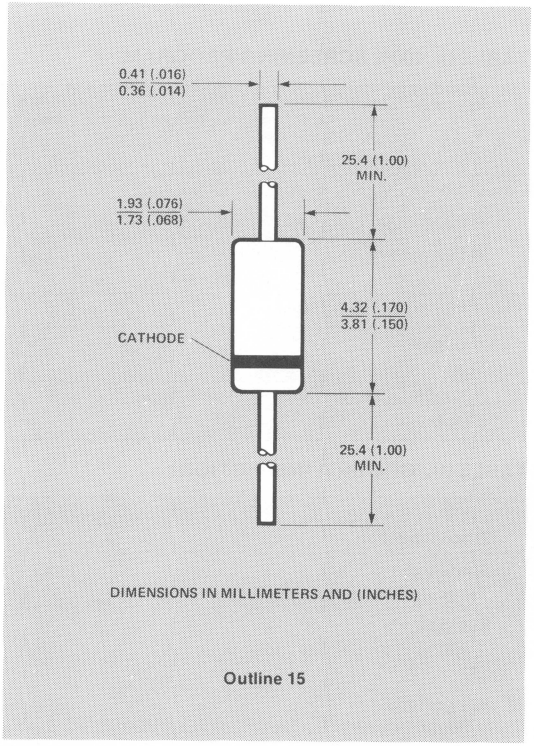
JAN 1N5712
JANTX 1N5712
JANTXV 1N5712

Features

PICO-SECOND SWITCHING SPEED

LOW TURN-ON VOLTAGE

LOW TEMPERATURE COEFFICIENT



Outline 15

Description/Applications

The JAN Series 1N5712 is an epitaxial, planar passivated Schottky Barrier Diode designed to have pico-second switching speed. These devices are well suited for VHF/UHF mixing and detecting, A/D converting, and switching applications that require the high reliability of a JAN/JANTX device.

Maximum Ratings

Operating and Storage Temperature Range ..... −65° C to 200° C
Reverse Voltage (Working) ..... 16 V (peak)
Power Dissipation at T_{CASE} = 25° C ..... 250 mW
Derate linearly at 1.43 mW/° C to zero at 200° C

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C
(Per Table I, Group A Testing of MIL-S-19500/445)

Specification	Symbol	Min.	Max.	Units	Test Conditions
Breakdown Voltage	V_{BR}	20		V_{dc}	I_R = 10 μA dc
Forward Voltage	V_{F1}		0.55	V_{dc}	I_{F1} = 1 mA dc
Forward Voltage	V_{F2}		1.0	V_{dc}	I_{F2} = 35 mA dc
Reverse Leakage Current	I_{R1}		150	nA dc	V_R = 16 V dc
Reverse Leakage Current	I_{R2}		150	μA dc	V_R = 16 V dc, T_A = 150° C
Capacitance	$C_{T(o)}$		1.2	pF	V_R = 0 V and f = 1 MHz
Effective Minority Carrier Lifetime	τ		100	pS	I_F = 5 mA Krakauer Method[1]

Notes:
1. Per DESC drawing C-68001.

JAN 1N5712: Samples of each lot are subjected to Group A inspection for parameters listed in Table I, and to Group B and Group C tests listed below. All tests are to the conditions and limits specified by MIL-S-19500/445.

JANTX 1N5712: Devices undergo 100% screening tests as listed below to the conditions and limits specified by MIL-S-19500/445* . A sample of the JANTX lot is then subjected to Group A, Group B, and Group C tests as for the JAN 1N5712 above.

JANTXV 1N5712: Devices are subject to 100% visual inspection in accordance with MIL-S-19500/445 prior to being subjected to TX screening.

*JANTX and JANTXV devices have gold plated leads.

TABLE II. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1.High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 200°C
2.Thermal Shock (Temperature Cycling)	1051	Condition C, 10 Cycles
3.Centrifuge (Constant Acceleration)	2006	20 KG, Y_1 axis.
4.Hermeticity Tests Fine Leak Gross Leak	1071	Condition G or H. Condition C or E
5.Interim Electrical Tests (I_R, V_F)		See Table I
6.Burn-In	1038	I_O = 33 mA (average), V_R = 16 V (peak) T_A = 25°C, f = 60 Hz, T = 96 hours.
7.Final Electrical Tests and Drift Evaluation (I_{R1}, V_{F1}) 10% PDA		$\Delta I_{R1} \leq$ 30 nA or 100% whichever is greater ΔV_{F1} = ±55 mV

TABLE III. GROUP A INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	V_{BR}, V_{F1}, V_{F2}, I_{R1}, CT_O, τ per Table I.	2
Subgroup 3 High Temperature Operation (T_A = 150° C) Reverse Currrent (I_{R2})	4016	per Table I.	2

TABLE IV. GROUP B INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Physical Dimensions	2066		15
Subgroup 2 Solderability	2026	Immerse to within 0.1 inch of body.	10
Thermal Shock (Temperature Cycling)	1051	Condition C, 10 Cycles	
Thermal Shock (Glass Strain)	1056	Condition A	
Terminal Strength (Tension)	2036	Condition A, 15 secs., 2 lbs.	
Hermetic Seal	1071	Condition E	
Moisture Resistance	1021	Omit initial conditioning	
End Points:			
Breakdown Voltage (V_{BR})	4021	Per Table I	
Forward Voltage (V_{F2})	4011	Per Table I	
Reverse Current (I_{R1})	4011	Per Table I	

TABLE IV. GROUP B INSPECTION (Cont.)

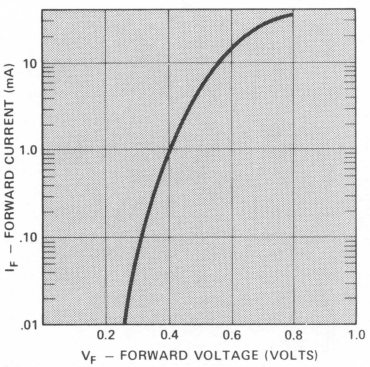
Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 3			
Shock	2016	Non-operating; 1500 G; t = 0.5 ms, 5 blows in each orientation X_1, Y_1, Y_2	10
Vibration Variable Frequency	2056	Non-operating	
Constant Acceleration	2006	Non-operating; 20 KG; X_1, Y_1, Y_2	
End Points: (same as Subgroup 2)			
Subgroup 4			
Terminal Strength; Lead Fatigue	2036	Test Condition E with lead restriction.	10
Subgroup 5			
High Temperature Life (Non-Operating)	1031	T_A = 200° C,[1]	$\lambda = 3$
End Points:			
Breakdown Voltage (V_{BR})	4021	18 V min. at 10 μA	
Forward Voltage (V_{F2})	4011	1.05 V max. at 35 mA	
Reverse Current (I_{R1})	4016	200 nA max. at 16 V	
Subgroup 6			
Steady State Operating Life	1026	I_O = 33 mA; V_R = 16 V (peak) f = 60 Hz, T_A = 25° C,[1]	$\lambda = 3$
End Points: (same as Subgroup 5)			

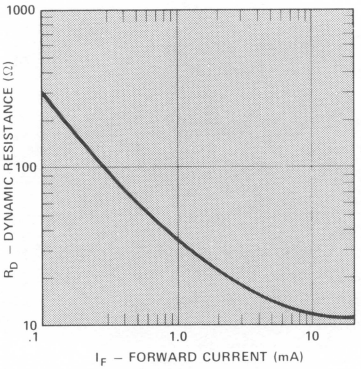
1. t = 1000 hours every 6 months to qualify product, t = 340 hours on each lot thereafter.

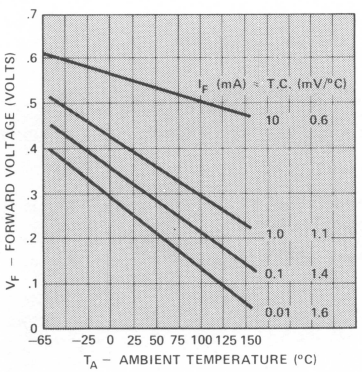
TABLE V. GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Salt Atmosphere (Corrosion)	1041		20
Subgroup 2			
Resistance to Solvents	MIL-STD-202 Method 215		10
Subgroup 3			
Thermal Shock (Temperature Cycling)	1051	Condition C. 25 cycles; time at temperature extremes = 15 minutes min., total test time = 72 hours max.	10
End Points:			
Breakdown Voltage (V_{BR})	4021	Per Table I	
Forward Voltage (V_{F2})	4011	Per Table I	
Reverse Current (I_{R1})	4016	Per Table I	
Subgroup 4			
Low Temperature Operation (−65° C)			20
Forward Voltage (V_{F1})	4011	Per Table I	
Forward Voltage (V_{F2})	4011	Per Table I	
Breakdown Voltage (V_{BR})	4021	Per Table I	

Typical Parameters







HEWLETT PACKARD

HIGH RELIABILITY GENERAL PURPOSE SCHOTTKY BARRIER DIODES

(Generic 5082-2810 and -2811)

TX-2810 TX-2811
TXB-2810 TXB-2811
TXV-2810 TXV-2811
TXVB-2810 TXVB-2811

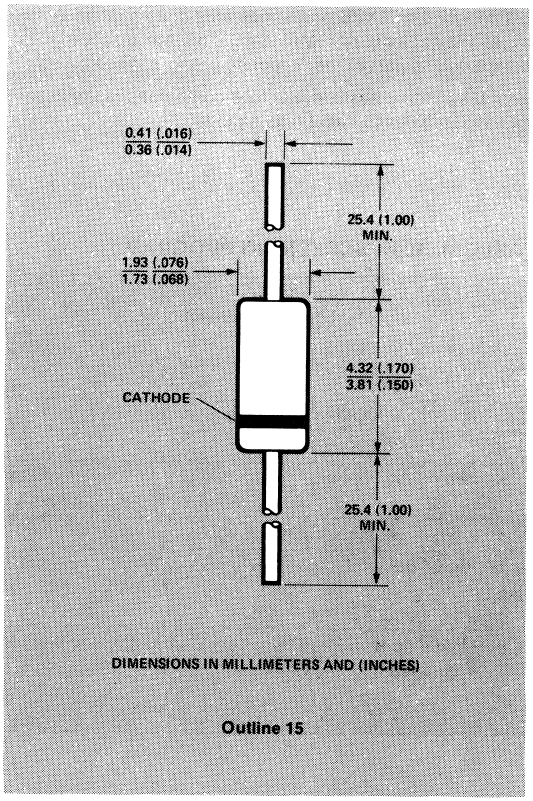
Features

MEDIUM TURN-ON VOLTAGE

PICO-SECOND SWITCHING SPEED

HERMETIC PACKAGE

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500



Description/Applications

The 5082-2810 and -2811 are passivated Schottky diodes which use a patented "guard ring" design to achieve a high breakdown voltage. They are packaged in a hermetically sealed glass package. They are well suited for high level detecting, mixing, switching, gating, log or A-D converting, video detecting, frequency discriminating, sampling, and wave shaping.

Maximum Ratings

Operating and Storage Temperature Range ..... −65° C to +200° C
Peak Inverse Voltage ..... V_{BR}
Power Dissipation at T_{CASE} = 25° C ..... 250 mW
Derate linearly at 1.43 mW/° C to zero at 200° C
Maximum Solder Temperature ..... 230° C for 5 seconds

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C (UNLESS OTHERWISE SPECIFIED)
Similar to 5082-2810 and 5082-2811

Part Number 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	V_F = 1 V Max. at Forward Current I_F (mA)	Maximum Reverse Leakage Current I_R (nA) at V_R (V)		Maximum Reverse Leakage Current at 125° C I_R (μA) at V_R (V)		Maximum Capacitance C_T (pF)
2810	20	410	35	100	15	150	15	1.2
2811	15		20	100	8	100	8	
Test Conditions	I_R = 10 μA	I_F = 1 mA						V_R = 0 V f = 1.0 MHz

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Table III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number	Screening Level
5082-2810 5082-2811	Commercial
TX-2810 TX-2811	100% Screen (per Tables III and IV)
TXB-2810 TXB-2811	100% Screen and Group B (per Tables III, IV and V)
TXV-2810 TXV-2811	100% Screen and Visual (per Tables III and IV)
TXVB-2810 TXVB-2811	100% Screen and Group B (per Tables III, IV and V) with visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (TXV only)	2074	
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 200° C
3. Thermal Shock (Temperature Cycling)	1051	Condition C, 10 Cycles
4. Constant Acceleration	2006	20 KG, Y_1 axis
5. Hermeticity Tests — Fine Leak Gross Leak	1071	Condition H Condition C
6. Interim Electrical Tests (V_F, I_{R1})		Per Table I
7. Power Burn-In	1038	Condition B, t = 96 hours, T_A = 25° C, V_R = 80% V_{BR}, f = 60 Hz, I_O = 20 mA DC (5082-2811), 33 mA DC (5082-2810)
8. Final Electrical Tests (See Table I) and Stability Verification		ΔV_F = ±55 mV, ΔI_{R1} = ±20 nA or 100% whichever is greater (5082-2811), ΔI_{R1} = ±30 nA or 100% whichever is greater (5082-2810)

TABLE IV. GROUP A ACCEPTANCE TEST

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	See Table I for Tests and Conditions (Read and Record)	5
Subgroup 3 Reverse Leakage (I_R) at T_A = 125° C	—	See Table I for Tests and Conditions (Read and Record)	5

TABLE V. GROUP B ACCEPTANCE TEST

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Physical Dimension	2066		15
Subgroup 2			
Solderability	2026		15
Resistance to Solvents	1022		
Electrical Test at 25° C (I_{R1}, V_F)		See Table I	
Subgroup 3			
Temperature Cycling	1051	Condition C, 10 Cycles	10
Thermal Shock	1056	Condition A	
Terminal Strength	2036	Condition A	
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
Moisture Resistance	1021		
Visual and Mechanical	2071		
Electrical Test at 25° C (I_{R1}, V_F)		See Table I	
Subgroup 4			
Mechanical Shock	2016		10
Vibration, Variable Frequency	2056		
Constant Acceleration	2006		
Electrical Test at 25° C		See Table I	
Subgroup 5			
Terminal Strength	2036	Condition E	15
Subgroup 6			
High Temperature Life (Non-operating)	1032	t = 340 hours, T_A = 200° C	5
Electrical Test at 25° C (I_{R1}, V_F)		See Table I	
Subgroup 7			
Steady State Operating Life	1027	t = 340 hours, T_A = 25° C, f = 60 Hz, V_R = 80% V_{BR}, I_O = 20 mA DC (5082-2811) I_O = 33 mA DC (5082-2810)	5
Electrical Test at 25° C (I_{R1}, V_F)		See Table I	

HEWLETT PACKARD

HIGH RELIABILITY SCHOTTKY SWITCHING DIODES
(Generic 5082-2835)

TX-2835
TXV-2835
TXB-2835
TXVB-2835

Features

SUITABLE FOR SPACE APPLICATIONS

LOW TURN-ON VOLTAGE

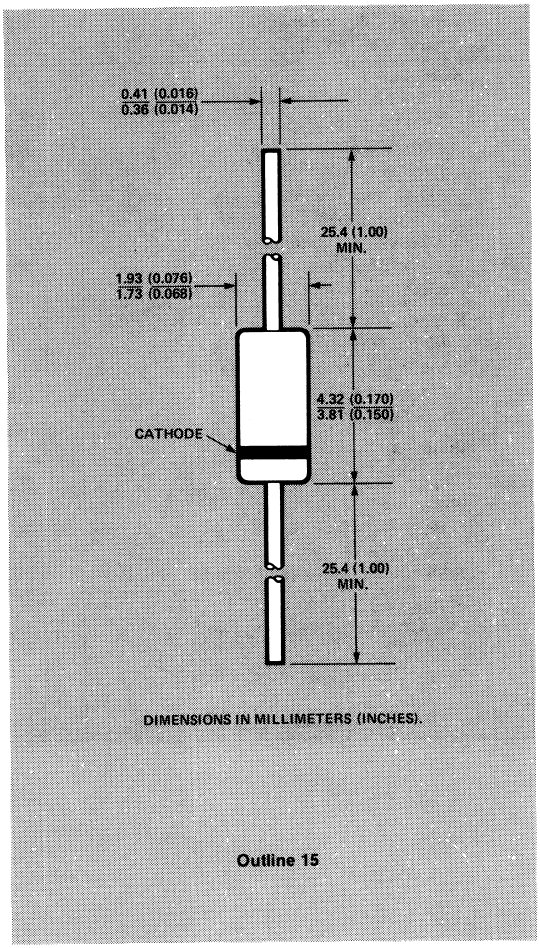
FAST SWITCHING

PLANAR PASSIVATED

LOW TEMPERATURE COEFFICIENT

UNIFORM FORWARD TRACKING

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500



Outline 15

Description/Applications

The TX-2835 is an epitaxial, planar passivated diode whose construction utilizes a metal-to-silicon junction. This results in extremely low forward voltage drops and ultra high speed switching, for applications that require high reliability screening.

The low forward voltage drop, combined with fast switching and high temperature capability, makes these devices attractive as replacements for germanium and silicon P/N junction diodes in such applications as low level switching, clamping, sampling, reference circuits, and low noise UHF mixers.

The uniformity of forward characteristics with current over the temperature range also makes these units suitable for circuitry requiring tight matching of characteristics.

Maximum Ratings

Power Dissipation at $T_{CASE} = 25°C$ ..... 150 mW
Derate linearly at 1.20 mW/°C to zero at 150°C
Operating Temperature Range ..... −60°C to +150°C
Storage Temperature Range ..... −60°C to +150°C

TABLE I. ELECTRICAL SPECIFICATIONS AT $T_A = 25°C$

Characteristics	Symbol	Min.	Max.	Units	Test Conditions
Breakdown Voltage	V_{BR}	8		volts	$I_R = 100\ \mu A$
Reverse Current	I_{R1}		100	nA	$V_R = 1$ V
Reverse Current	I_{R2}		100	μA	$V_R = 1$ V, t = 125°C
Forward Voltage	V_{F1}		0.34	volts	$I_F = 1$ mA
Forward Voltage	V_{F2}		0.45	volts	$I_F = 10$ mA
Capacitance	C_{TO}		1.0	pF	$V_R = 0$, f = 1 MHz
Effective Minority Carrier Lifetime	τ		100	psec	$I_F = 20$ mA

PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

TX-2835	Devices undergo 100% screening as specified in Table II and Table III (excluding step 1).
TXV-2835	Devices undergo 100% screening per Table II and Table III.
TXB-2835	Following 100% screen per Table II (delete step 1), samples of lot are subjected to Group A (Table III), and Group B (Table IV).
TXVB-2835	Complete screen and lot qualification per Tables II-IV.

TABLE II. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method (Except as Noted)	Conditions
1. Internal Visual	2074	
2. High Temperature Storage	1032	48 Hours minimum at 150° C
3. Temperature Cycling	1051	Condition F — 20 cycles, 10 minutes at extremes (-60° C to +150° C)
4. Constant Acceleration	2006	20 KG, Y_1 axis
5. Hermetic Seal Fine Leak Gross Leak	1071	Condition H, 5×10^{-8} cc/sec max. Condition C
6. Interim Electrical Test I_{R1}, V_{BR}, C_{TO}, V_{F1}, V_{F2}	—	Read and Record
7. Burn-In	1038	Condition B, P_{FM} = 150 mW pk., V_{RM} = 5 V pk., f = 60 Hz, t = 168 hr. min., T_A = 25° C
8. Final Electrical Test	—	Same as Step 7
9. Electrical Stability Verification		$\Delta I_{R1} \leq$ 50 nA or 100% of initial value, whichever is greater $\Delta V_{F1} \leq$ 10% of initial value
10. Percent Defective Allowable (PDA)		10% of devices submitted to burn-in.

TABLE III. GROUP A ACCEPTANCE TEST

Test/Inspection	MIL-STD-750 Method	Conditions	LTPD
Subgroup 1 External Visual Inspection	2071		5
Subgroup 2 Electrical Test I_{R1}, V_{BR}, C_{TO}, V_{F1}, V_{F2} at T_A = 25° C		See Table I (Read and Record)	3
Subgroup 3 Electrical Test at T_A = 25° C Carrier Lifetime (τ)		See Table I (Read and Record)	3
Subgroup 4 Electrical Test Reverse Leakage (I_R) at T_A = 125° C		See Table I (Read and Record)	7

TABLE IV. GROUP B PROGRAM

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 3			
Steady State Operating Life	1027	t = 340 hours, T_A = 25°C, PFM = 150 mW, f = 60 Hz, V_{RM} = 5 V (pk).	5
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 4			
Decap Internal Visual (Design Verification)	2075	One Device Only	
Subgroup 5			
High Temperature Life (Non-Operating)	1032	t = 340 hours, T_A = 150°C	7
DC Electrical Tests (I_R and V_F)		See Table I.	

HEWLETT PACKARD

HIGH RELIABILITY ZERO BIAS SCHOTTKY DETECTOR DIODE

(Generic HSCH-3486)

HSCH-0812

Features

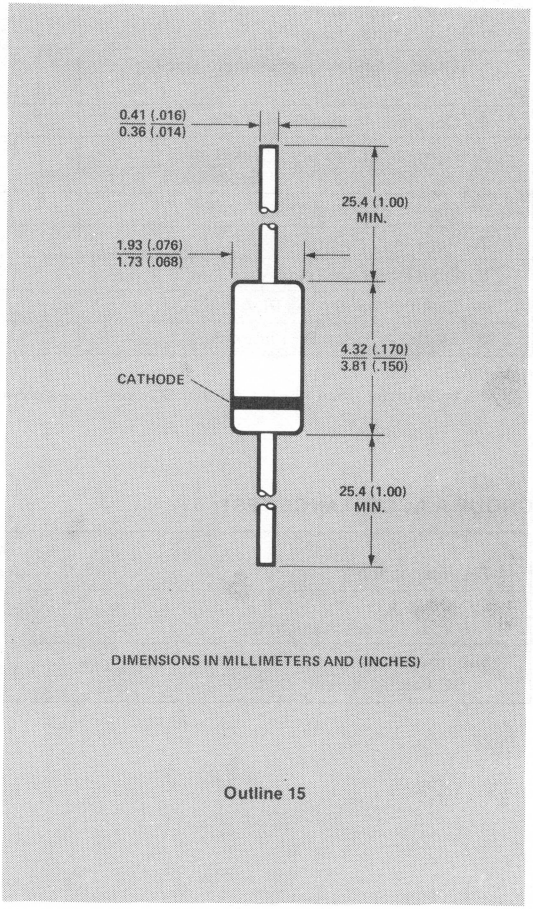
HIGH TANGENTIAL SENSITIVITY

NO BIAS REQUIRED

HERMETIC GLASS PACKAGE

QUALITY PERFORMANCE TESTED

Test Program Patterned after MIL-S-19500



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 15

Description/Applications

The high tangential sensitivity of these Schottky Barrier diodes makes them ideally suitable for narrow bandwidth video detectors, ECM receivers, and measurement equipment. These diodes also make excellent mixers for use with low power LO.

Maximum Ratings

Operating and Storage Temperature Range ..... −65° C to +150° C

CW Power Dissipation at T_{CASE} = 25° C ..... 300 mW

Derate linearly at 2.40 mW/° C to zero at 150° C

Pulse Power Dissipation

Peak Power absorbed by the diode at T_A = 25° C

1 μs pulse, Du = 0.001 ..... 1 W

These diodes are ESD sensitive. Handle with care to avoid static discharge through the diode.

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C

Part Number	Maximum Tangential Sensitivity TSS (dBm)	Minimum Voltage Sensitivity γ (mV/μW)	Video Resistance R_V (KΩ) Min.	Video Resistance R_V (KΩ) Max.	Maximum Forward Voltage V_F (mV)	Typical Total Capacitance C_T (pF)
HSCH-0812 (Screened HSCH-3486)	−54	7.5	2	8	400	0.30
Test Conditions	Video Bandwidth = 2 MHz f_{test} = 10 GHz	Power in = −40 dBm f_{test} = 10 GHz			I_F = 1 mA	V_R = 0 V f = 1 MHz

High Reliability Conditioning and Acceptance Testing

(All methods are per MIL-STD-750 unless otherwise specified)

100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual Inspection	—	Per H.P. Method A-5956-0562-72
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours., T_A = 150° C
3. Thermal Shock (Temperature Cycling)	1051	−65° C to +150° C, 10 cycles, 30 minutes per cycle
4. Constant Acceleration	2006	20 KG, Y_1 axis.
5. Hermeticity Tests Fine Leak Gross Leak	1071	Condition G or H. Condition C.
6. Interim Electrical Tests (V_F)		Per Table I. T_A = 25° C.
7. Burn-in	1038	P = 10 mW, T_A = 25° C, t = 168 hours
8. Final Electrical Tests (V_F)		Per Table I. T_A = 25° C
9. Drift Evaluation PDA = 15 [1]		$\Delta V_F = \pm 5$ mV
10. Electrical Tests, RF Parameters		

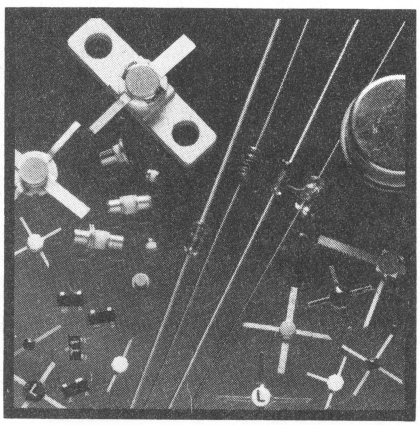
Note:

1. If rejects are greater than 15% but less than 30%, one more burn-in may be performed with a new 10% PDA.

GROUP A ACCEPTANCE TEST

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		15
Subgroup 2 DC Electrical Tests at 25° C		Per Table I	5

Reliability Data for Schottky Diodes

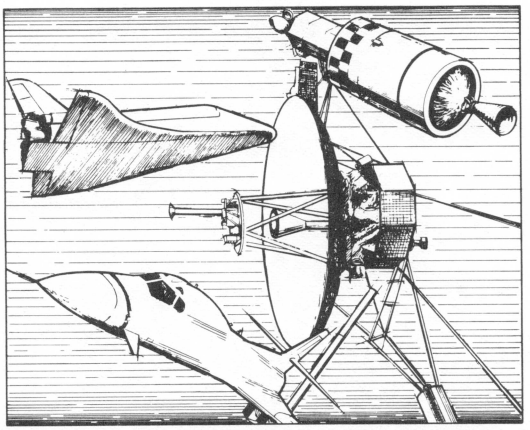


HEWLETT PACKARD

RELIABILITY DATA SURFACE MOUNT SCHOTTKY DIODES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the current review of accumulated test results. All data recorded here is for passivated Schottky diodes mounted in SOT-23 surface mount packages.

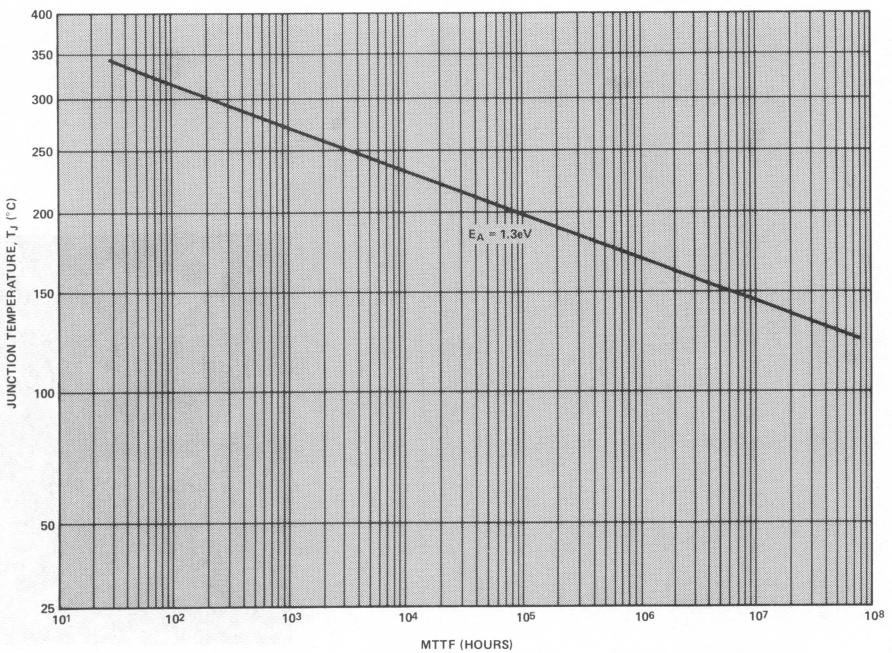


Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-S-19500 test screening. Reliability can be guaranteed only under the specified conditions at 90% confidence level.

Applicable Part Numbers

HSMS-28XX Series HSMS-00XX Series



Mean Time to Failure vs. Junction Temperature

Life and Environmental Test Performance

HSMS-280X LIFE TESTS[1]

Test	Conditions	Total Device Hours Tested	Number of Failures*
High Temperature Reverse Bias	T_A = 125° C, V_R = 56V	50,000	0
Room Temperature Operating Life	T_A = 25° C, P_{FM} = 250 mW	50,000	0
High Temperature Operating Life	10 mA D.C., T_A = 125° C	50,000	0
High Temperature Storage	T_A = 125° C	31,200	0

HSMS-280X ENVIRONMENTAL TESTS[1]

Test	MIL-STD-750	Condition	Total Devices Tested	Number of Failures*
Thermal Shock	1056	-65° to 125° C, 100 cycles	63	0
Temperature Cycling	1051C	-65° to 125° C, 100 cycles	75	0
Mechanical Shock	2016	1500G, 5 blows, each at X_1, X_2, Y, 0.5 msec pulse	63	0
Vibration Variation Frequency	2056	20G minimum, 100 Hz - 2 KHz	38	0
Autoclave	—	15PSIG, 121° C, 96 hours	114	0
Polarized Moisture Resistance	1021	V_R = 80% V_{BR}, 1000 hours	24	0
Lead Strength	—	Pull to Destruction	20	$\bar{P}$ = 3.9 pounds
Solderability	—	Vapor Phase (solder is Sn63-Pb37) & Drag Solder (solder is Sn60-Pb40)	50	0
Solder Heat	—	260° C, 10 seconds	110	0
Salt Atmosphere	1041	20% Salt, 35° C 24 hours	—	—
Bond Strength**	—	Push to Destruction	20	$\bar{F}$ = 7.0 pounds

Note:
1. Includes HSMS-0001/0011 chips.

HSMS-281X LIFE TESTS[2]

Test	Conditions	Total Device Hours Tested	Number of Failures*
High Temperature Reverse Bias	T_A = 125° C, V_R = 16V	164,780	0
Room Temperature Operating Life	T_A = 25° C, P_{FM} = 250 mW	136,900	0
High Temperature Operating Life	10 mA D.C., T_A = 125° C	30,900	0
High Temperature Storage	T_A = 125° C	43,500	0

Note:
2. Includes HSMS-0002/0012 chips.

*Failure Criteria per MIL-S-19500.
**Units bonded by Vapor-Phase Soldering. All bond failures occurred at solder joints by pushing units vertically.

HSMS-281X ENVIRONMENTAL TESTS[2]

Test	MIL-STD-750	Condition	Total Devices Tested	Number of Failures*
Thermal Shock	1056	-65° to 125° C, 100 cycles	87	0
Temperature Cycling	1051C	-65° to 125° C, 100 cycles	44	0
Mechanical Shock	2016	1500G, 5 blows, each at X_1, X_2, Y, 0.5 msec pulse	40	0
Vibration Variation Frequency	2056	20G minimum, 100 Hz - 2 KHz	45	0
Autoclave	—	15PSIG, 121° C, 96 hours	87	0
Polarized Moisture Resistance	1021	V_R = 80% V_{BR}, 1000 hours	30	0
Lead Strength	—	Pull to Destruction	20	$\bar{P}$ = 3.9 pounds
Solderability	—	Vapor Phase (solder is Sn63-Pb37) & Drag Solder (solder is Sn60-Pb40)	50	0
Solder Heat	—	260° C, 10 seconds	47	0
Salt Atmosphere	1041	20% Salt, 35° C 24 hours	25	—
Bond Strength**	—	Push to Destruction	20	$\bar{F}$ = 7.0 pounds

Note:
2. Includes HSMS-0002/0012 chips.

HSMS-282X LIFE TESTS[3]

Test	Conditions	Total Device Hours Tested	Number of Failures*
High Temperature Reverse Bias	T_A = 125° C, V_R = 5V	159,265	0
Room Temperature Operating Life	T_A = 25° C, P_{FM} = 250 mW	132,000	0
High Temperature Operating Life	10 mA D.C., T_A = 125° C	121,000	0
High Temperature Storage	T_A = 125° C	65,000	0

HSMS-282X ENVIRONMENTAL TESTS[3]

Test	MIL-STD-750	Condition	Total Devices Tested	Number of Failures*
Thermal Shock	1056	-65° to 125° C, 100 cycles	159	0
Temperature Cycling	1051C	-65° to 125° C, 100 cycles	135	0
Mechanical Shock	2016	1500G, 5 blows, each at X_1, X_2, Y, 0.5 msec pulse	25	0
Vibration Variation Frequency	2056	20G minimum, 100 Hz - 2 KHz	80	0
Autoclave	—	15PSIG, 121° C, 96 hours	209	0
Polarized Moisture Resistance	1021	V_R = 80% V_{BR}, 1000 hours	45	0
Lead Strength	—	Pull to Destruction	20	$\bar{P}$ = 3.9 pounds
Solderability	—	Vapor Phase (solder is Sn63-Pb37) & Drag Solder (solder is Sn60-Pb40)	50	0
Solder Heat	—	260° C, 10 seconds	203	0
Salt Atmosphere	1041	20% Salt, 35° C 24 hours	25	—
Bond Strength**	—	Push to Destruction	20	$\bar{F}$ = 7.0 pounds

Note:
3. Includes HSMS-0003/0013 chips.

*Failure Criteria per MIL-S-19500.
**Units bonded by Vapor-Phase Soldering. All bond failures occurred at solder joints by pushing units vertically.

Life and Environmental Test Performance (cont.)

HSMS-284X LIFE TESTS

Test	Conditions	Total Device Hours Tested	Number of Failures*
High Temperature Reverse Bias	T_A = 125° C, V_R = 40 V	50,000	0
Room Temperature Operating Life	T_A = 25° C, P_{FM} = 250 mW	50,000	0
High Temperature Operating Life	10 mA D.C., T_A = 125° C	50,000	0
High Temperature Storage	T_A = 125° C	31,200	0

HSMS-284X ENVIRONMENTAL TESTS

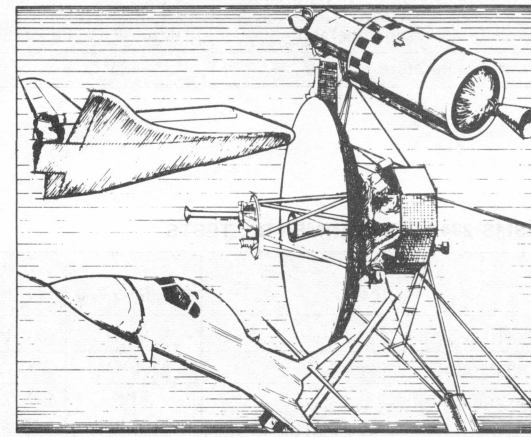
Test	MIL-STD-750	Condition	Total Devices Tested	Number of Failures*
Thermal Shock	1056	-65° to 125° C, 100 cycles	63	0
Temperature Cycling	1051C	-65° to 125° C, 100 cycles	75	0
Mechanical Shock	2016	1500G, 5 blows, each at X_1, X_2, Y, 0.5 msec pulse	63	0
Vibration Variation Frequency	2056	20G minimum, 100 Hz - 2 KHz	38	0
Autoclave	—	15PSIG, 121° C, 96 hours	114	0
Polarized Moisture Resistance	1021	V_R = 80% V_{BR}, 1000 hours	24	0
Lead Strength	—	Pull to Destruction	20	$\bar{P}$ = 3.9 pounds
Solderability	—	Vapor Phase (solder is Sn63-Pb37) & Drag Solder (solder is Sn60-Pb40)	50	0
Solder Heat	—	260° C, 10 seconds	110	0
Salt Atmosphere	1041	20% Salt, 35° C 24 hours	—	—
Bond Strength**	—	Push to Destruction	20	$\bar{F}$ = 7.0 pounds

HEWLETT PACKARD

RELIABILITY DATA PASSIVATED GENERAL PURPOSE SCHOTTKY DIODES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for passivated Schottky diodes mounted in hermetically sealed glass packages.

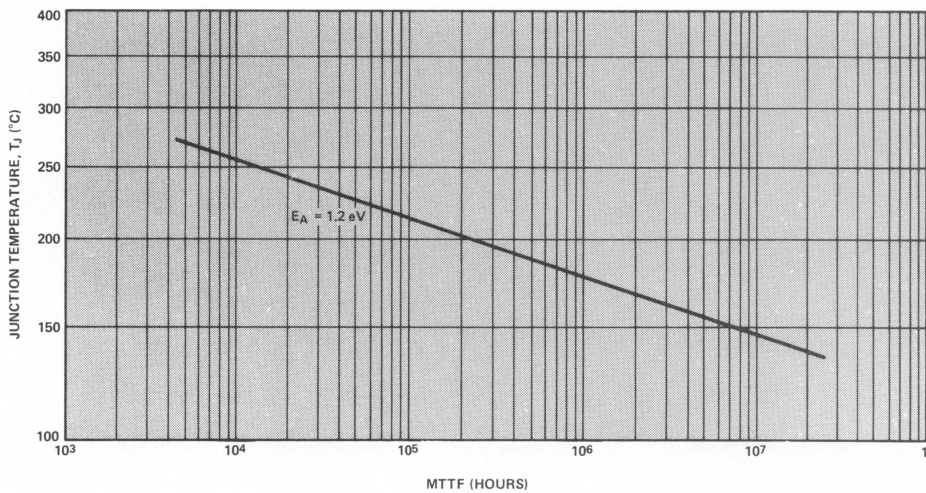


Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-S-19500 test screening. Reliability can be guaranteed only under specified conditions by testing specific lots, under specified conditions and LTPD levels.

Applicable Part Numbers

1N5711	5082-0097	5082-2814
1N5712	5082-2080	5082-2815
5082-0024	5082-2800	5082-2817
5082-0057	5082-2804	5082-2818
5082-0058	5082-2805	5082-2824
5082-0087	5082-2810	5082-2826
5082-0094	5082-2811	5082-2835
	5082-2813	5082-2836



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions[1]	LTPD per 1000 Hours
High Temperature Life	Storage at: 200° C	2.0
Steady State Operating Life	P_{FM} = 250 mW V_{RM} = 80% of V_{BR} T_A = 25° C f = 60 Hz	2.0
High Temperature Reverse Bias	V_R = 80% of V_{BR} T_A = 200° C	2.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

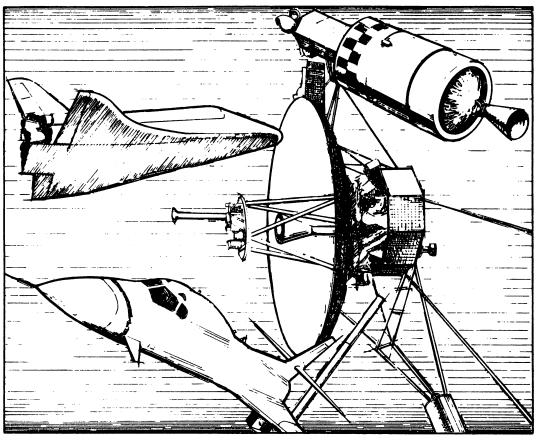
Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from –65° C to 200° C, 5 hrs. at extremes, 5 min. transfer	10
Thermal Shock	1056	10 cycles from 0° C to 100° C, 3 sec. transfer	10
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	10
Vibration Fatigue	2046	20G min., 60 Hz	10
Vibration Variable Frequency	2056	4, 4 min. cycles each X, Y, Z at 20G min., 100 to 2000 Hz	10
Constant Acceleration	2006	20KG, 1 minute per axis	5
Moisture Resistance	1021	240 hours, 90-98% relative humidity	10
Salt Atmosphere	1041	35° C fog for 24 hours	5
Solderability	2026	Sn 60, Pb 40, 230° C	10

HEWLETT PACKARD

RELIABILITY DATA TRI METAL BEAM LEAD SCHOTTKY DIODES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for tri metal beam lead Schottky diodes mounted in hermetically sealed H packages.

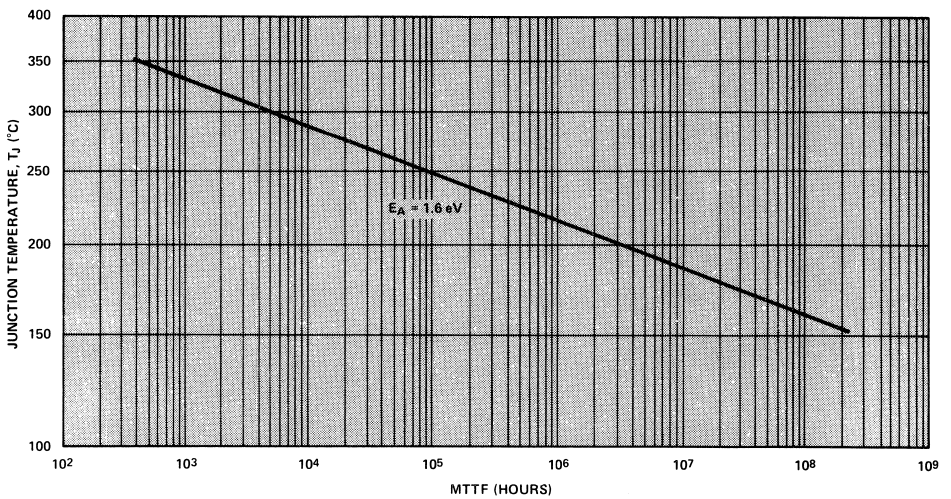


Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-S-19500 test screening. Reliability can be guaranteed only under specified conditions by testing specific lots, under specified conditions and LTPD levels.

Applicable Part Numbers

HSCH-5300 Series	5082-2203	5082-2774
HSCH-5500 Series	5082-2207	5082-2775
HSCH-5800 Series	5082-2208	5082-2785
HSCH-6000 Series	5082-2209	5082-2786
5082-2200	5082-2210	5082-2794
5082-2201	5082-2765	5082-2795
5082-2202	5082-2766	5082-2837



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions[1]	LTPD per 1000 Hours
High Temperature Life	Storage at: 200° C	2.0
Steady State Operating Life	I_F = 10 mA DC T_A = 175° C f = 60 Hz	2.0
High Temperature Reverse Bias	V_R = 80% of V_{BR} T_A = 175° C	2.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from –65° C to 200° C, 5 hrs. at extremes, 5 min. transfer	6
Thermal Shock	1056	10 cycles from 0° C to 100° C, 3 sec. transfer	6
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	6
Vibration Fatigue	2046	20G min., 60 Hz	6
Constant Acceleration	2006	20KG, 1 minute per axis	6
Moisture Resistance	1021	240 hours, 90-98% relative humidity	6
Salt Atmosphere	1041	35° C fog, 24 hours	10

HEWLETT PACKARD

RELIABILITY BULLETIN TRI METAL BEAM LEAD SCHOTTKY DIODES

Conclusion

Hewlett-Packard's beam lead diodes have successfully passed stringent environmental testing. Hewlett-Packard beam lead diodes may be used in military and space applications without the necessity of hermetically sealed packaging.

General

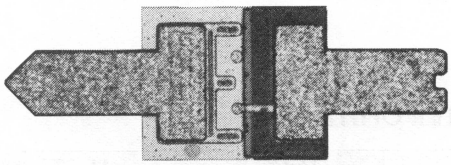
For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the specified design criteria. All Schottky beam lead families have fulfilled the standard requirements of reliability qualification, and the results of these tests are available upon request from Hewlett-Packard.

Program Description

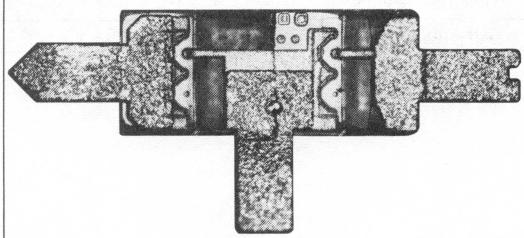
The purpose of this program is to qualify all beam lead diodes for operation in extreme environmental conditions which may be encountered during military and space operations.

The following test sequence has been designed to assess the endurance of beam lead diodes through relevent environmental stresses such as heat and humidity. To qualify a device as hermetic, the conventional procedure is to perform dye-penetrant and Radiflo tests. However, because of the absence of an enclosed cavity in the unique design of the beam lead diode, these tests are not directly applicable. Therefore, this program utilizes reliability tests such as moisture resistance, salt atmosphere, and immersion to verify that the passivation layer on the beam lead acts as a seal to protect the active area of the diode.

To perform these tests, various Schottky diodes were mounted in non-hermetic, open packages and tested as exposed beam lead devices.



SINGLE



PAIR

Typical Beam Lead Outlines

Applicable Part Numbers

Schottky Beam Leads

5082-2837
HSCH-5300 Series
HSCH-5500 Series
HSCH-5800 Series
HSCH-6000 Series

Test Sequence

Test	MIL-STD-750	Test Condition	Units Tested	Failed	LTPD
Moisture Resistance [1, 2]	1021	98% R.H. –10° C to 65° C, 10 days			
Temperature Cycling	1051	–65° C to 200° C, 100 cyc.	80	0	<7
Constant Acceleration	2006	20 KG, 1 min. each axis	(40 per lot)		
Salt Atmosphere [2]	1041	35° fog, 24 hours	25	0	<10
Salt Water Immersion [2]	(MIL-STD-883, M1002B)	65° C saturated NaCl solution, 2 cycles	25	0	<10

Notes:
1. The sequence of moisture resistance and temperature cycling followed by constant acceleration assures a thorough evaluation of the effect of exposure to high humidity and heat conditions. End points were taken after each test.
2. End points were: Visual at 100X magnification and D.C. testing to MIL-STD-19500.

Results

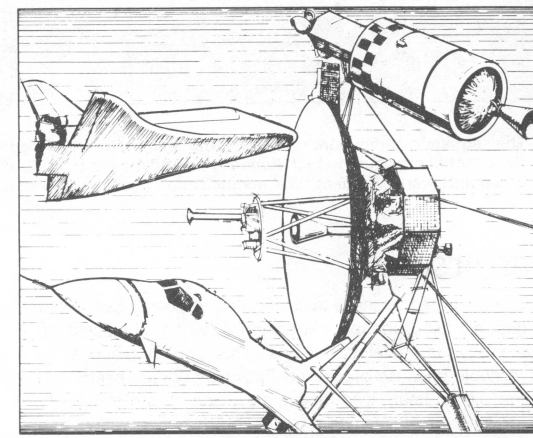
As demonstrated by these tests, Hewlett-Packard's beam lead diodes exhibit superior performance when subjected to severe environmental conditions. This proven reliability is achieveable because of Hewlett-Packard's unique beam lead design. These beam lead diodes are made of tri-metal (Ti-Pt-Au or NiCr-Pt-Au), which extends both the operating and storage temperature range. In addition, a nitride passivation layer acts as a sealant and provides immunity from contaminants which could lead to I_R drift. Conductive particle protection is provided by a layer of polyimide, which also functions as scratch protection. Therefore, it is recommended that Hewlett-Packard beam lead diodes be used in military and space applications without the necessity of hermetically sealed packaging.

HEWLETT PACKARD

RELIABILITY DATA BI METAL BEAM LEAD SCHOTTKY DIODES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for bi metal beam lead Schottky diodes mounted in non-hermetically sealed E-1 packages.

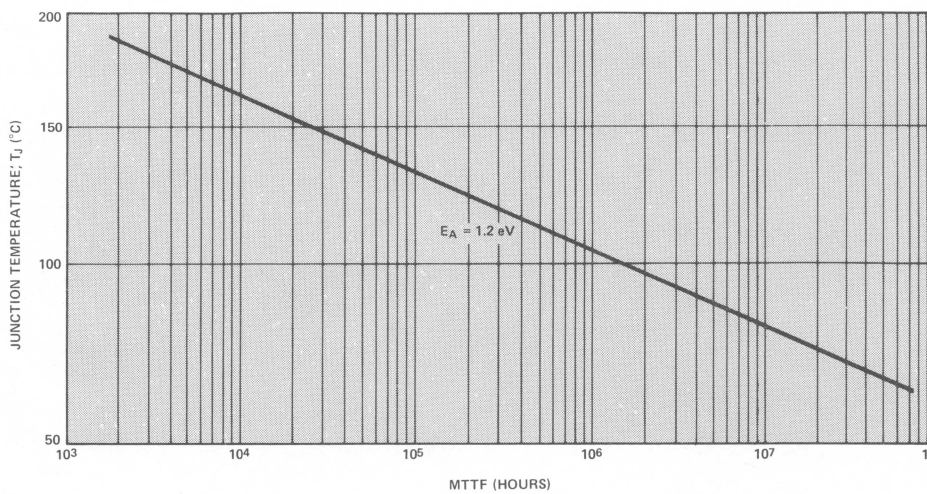


Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-S-19500 test screening. Reliability can be guaranteed only under specified conditions and LTPD levels.

Applicable Part Numbers

5082-2231	5082-2277	5082-2294
5082-2233	5082-2279	5082-2830
5082-2263	5082-2280	5082-2831
5082-2271	5082-2291	5082-9300 Series
5082-2272	5082-2292	5082-9600 Series



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions [1]	LTPD per 1000 Hours
High Temperature Life	Storage at 125° C	2.0
Steady State Operating Life	P_{FM} = 50 mW T_A = 25° C f = 60 Hz	2.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

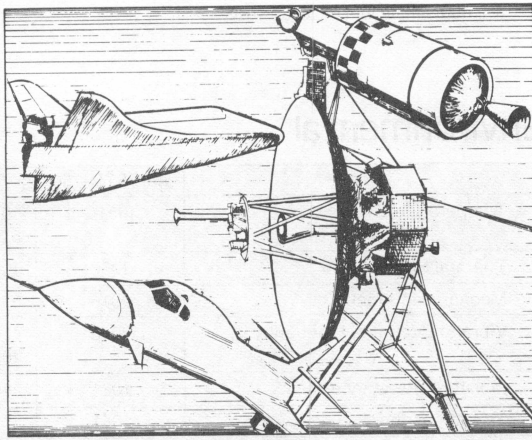
Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from −65° C to 125° C, 5 hrs. at extremes, 5 min. transfer	10
Thermal Shock	1056	10 cycles from 0° C to 100° C, 3 sec. transfer	10
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	10
Vibration Variable Frequency	2056	4, 4 min. cycles each X, Y, Z at 20G min., 100 to 2000 Hz	10
Moisture Resistance	1021	240 hours, 90-98% relative humidity	10
Salt Atmosphere	1041	35° C fog for 24 hours	10
Solderability	2026	Sn 60, Pb 40, 230° C	10

HEWLETT PACKARD

RELIABILITY DATA
MESH SCHOTTKY DIODES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for mesh Schottky diodes mounted in hermetically sealed glass packages.

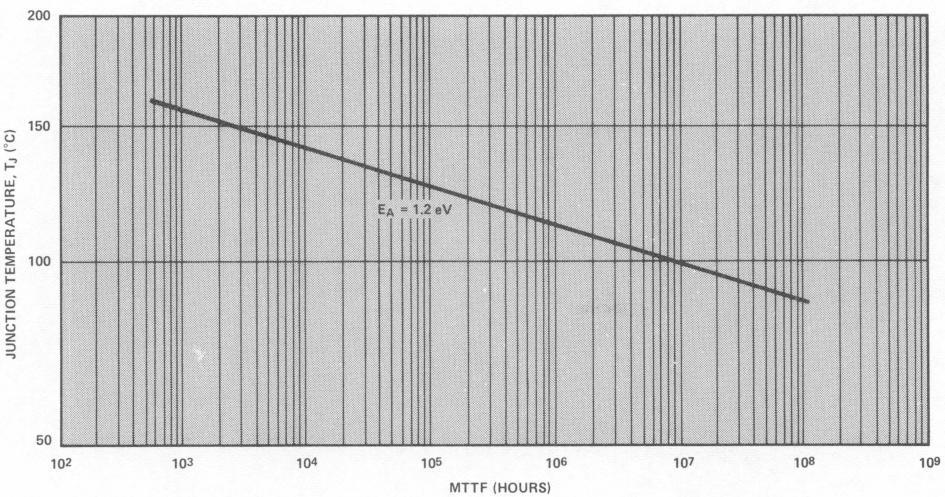


Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-S-19500 test screening. Reliability can be guaranteed only under specified conditions and LTPD levels.

Applicable Part Numbers

5082-2301	5082-2356	5082-2566
5082-2302	5082-2370	5082-2755
5082-2303	5082-2396	5082-2787
5082-2305	5082-2400	5082-2900
5082-2306	5082-2401	5082-2912
5082-2308	5082-2520	5082-2970
5082-2350	5082-2521	5082-2997
5082-2351	5082-2565	HSCH-3486



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions [1]	LTPD per 1000 Hours
High Temperature Life	Storage at 100° C	2.0
Steady State Operating Life	P_{FM} = 125 mW V_{RM} = 80% of V_{BR} T_A = 25° C f = 60 Hz	2.0
High Temperature Reverse Bias	V_R = 80% of V_{BR} T_A = 100° C	3.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

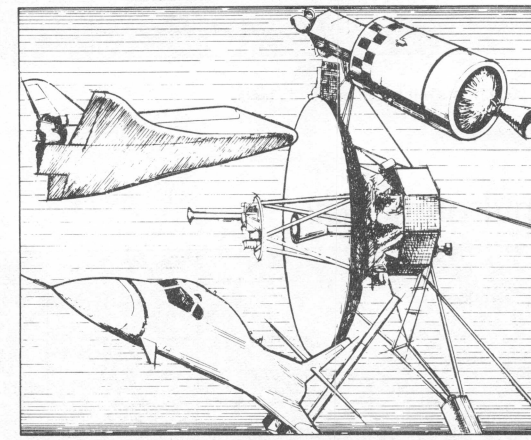
Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from –65° C to 100° C, 5 hrs. at extremes, 5 min. transfer	10
Thermal Shock	1056	10 cycles from 0° C to 100° C, 3 sec. transfer	10
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	10
Vibration Variable Frequency	2056	4, 4 min. cycles each X, Y, Z at 20G min., 100 to 2000 Hz	10
Moisture Resistance	1021	240 hours, 90-98% relative humidity	10
Terminal Strength	2036	Condition A	10
Solderability	2026	Sn 60, Pb 40, 230° C	10

HEWLETT PACKARD

RELIABILITY DATA PASSIVATED N-TYPE MICROWAVE SCHOTTKY DIODES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for N-type passivated microwave Schottky diodes mounted in non-hermetic unsealed 44 packages.

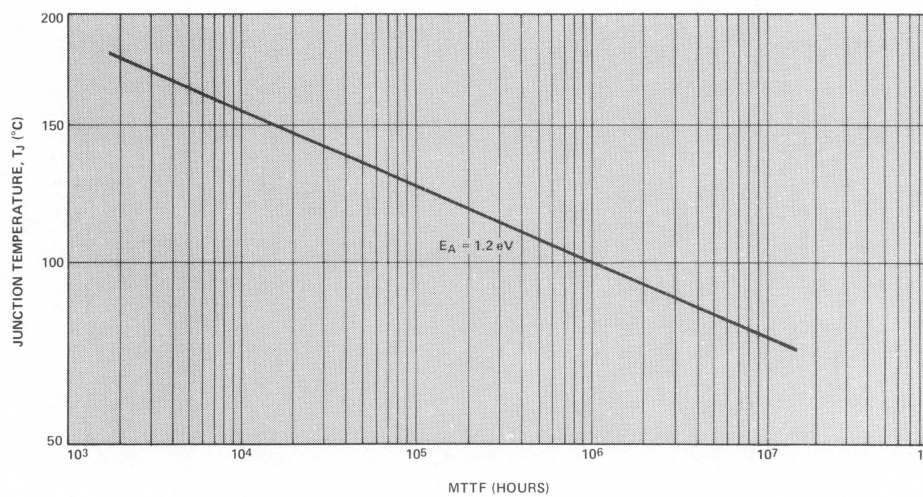


Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-S-19500 test screening. Reliability can be guaranteed only under specified conditions and LTPD levels.

Applicable Part Numbers

5082-0013	5082-2297	5082-2712
5082-0023	5082-2298	5082-2713
5082-0029	5082-2701	5082-2714
5082-0041	5082-2702	5082-2723
5082-2273	5082-2706	5082-2724
5082-2274	5082-2707	HSCH-3206
5082-2295	5082-2711	HSCH-3207
5082-2296		



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions[1]	LTPD per 1000 Hours
High Temperature Life	Storage at 125° C	3.0
Steady State Operating Life	P_{FM} = 75 mW V_{RM} = 80% of V_{BR} T_A = 25° C f = 60 Hz	4.0

Note:
1. 1000 hours minimum on all life tests.

Environmental

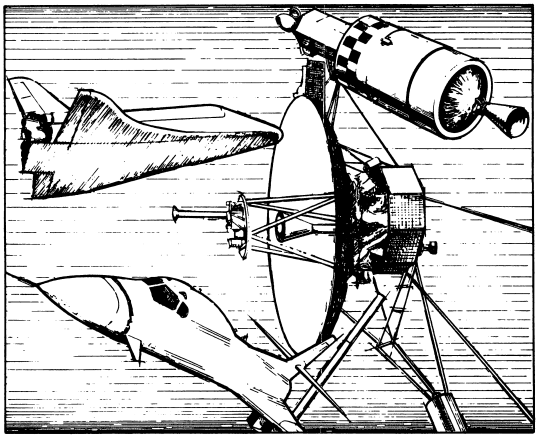
Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from −65° C to 125° C, 5 hrs. at extremes, 5 min. transfer	10
Thermal Shock	1056	10 cycles from 0° C to 100° C, 3 sec. transfer	10
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	10
Vibration Fatigue	2046	20G min., 60 Hz	10
Vibration Variable Frequency	2056	4, 4 min. cycles each X, Y, Z at 20G min., 100 to 2000 Hz	10
Constant Acceleration	2006	20KG, 1 minute per axis	10
Moisture Resistance	1021	240 hours, 90-98% relative humidity	10
Salt Atmosphere	1041	35° C fog for 24 hours	12

HEWLETT PACKARD

RELIABILITY DATA PASSIVATED P-TYPE MICROWAVE SCHOTTKY DIODES

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the design criteria. Periodically, additional tests are run. The data on this sheet represents the latest review of accumulated test results. All data recorded here is for P-type passivated microwave Schottky diodes mounted in non-hermetic unsealed 44 packages.

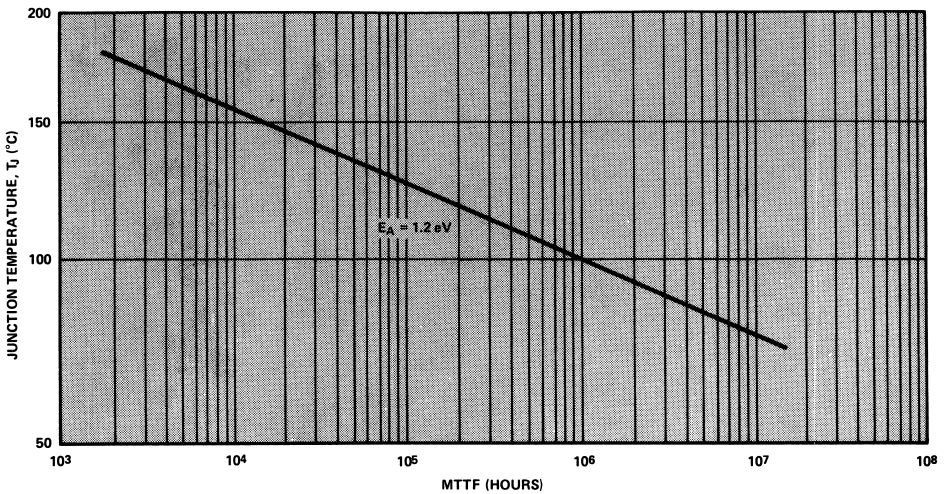


Applications

This information represents the capabilities of the generic device. Failure rate and MTTF values presented here are achievable with normal MIL-S-19500 test screening. Reliability can be guaranteed only under specified conditions by testing specific lots, under specified conditions and LTPD levels.

Applicable Part Numbers

5082-0009
5082-2750
5082-2751
5082-9891



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions[1]	LTPD per 1000 Hours
High Temperature Life	Storage at 125° C	4.0
Steady State Operating Life	P_{FM} = 100 mW V_{RM} = 80% of V_{BR} T_A = 25° C f = 60 Hz	3.0

ote:
. 1000 hours minimum on all life tests.

Environmental

Test	MIL-STD-750	Test Condition	LTPD
Temperature Cycling	1051C	10 cycles from –65° C to 200° C, 5 hrs. at extremes, 5 min. transfer	10
Thermal Shock	1056	10 cycles from 0° C to 100° C, 3 sec. transfer	10
Mechanical Shock	2016	5 blows each at X_1, X_2, Y, 1500G, 0.5 msec. pulse	10
Vibration Fatigue	2046	20G min., 60 Hz	10
Vibration Variable Frequency	2056	4, 4 min. cycles each X, Y, Z at 20G min., 100 to 2000 Hz	10
Moisture Resistance	1021	240 hours, 90-98% relative humidity	10
Salt Atmosphere	1041	35° C fog for 24 hours	12

ABSTRACTS OF APPLICATION NOTES AND BULLETINS FOR SCHOTTKY DIODES

The Microwave Semiconductor Division field sales force is supported by a division applications staff. These technical specialists investigate circuit applications of most interest to the users of these semiconductor devices. The results of these investigations are reported in application notes or brief application bulletins. A complete list with brief abstracts is presented here.

Below is a brief summary of Application Notes for diodes and transistors. All of the Application Notes are available from your local HP Sales Office or nearest Components Authorized Distributor or Representative.

AN 923 Hot Carrier Diode Video Detectors

Describes the characteristics of HP Schottky barrier diodes intended for use in video detector or video receiver circuits, and discusses some design features of such circuits.

Though less sensitive then the heterodyne receiver, the many advantages of the video receiver make it extremely useful. The Schottky diode can be used to advantage in applications such as beacon, missile-guidance, fuse-activating, and counter-measure receivers, and as power-leveling and signal-monitoring detectors.

Among the subjects discussed are the performance characteristics of video detector diodes — tangential sensitivity, video resistance, voltage sensitivity and figure of merit; how these characteristics affect the bandwidth of a video detector, video detector design considerations; considerations that affect dynamic range; and considerations that vary the level at which burnout can occur.

AN 942 Schottky Diodes for High Volume Low-Cost Applications

Discusses switching, sampling, mixing, and other applications where the substitution of Schottky diodes will provide significant improvement over PN junction devices.

AN 956-1 The Criterion for the Tangential Sensitivity Measurement

Discusses the meaning of Tangential Sensitivity and a recommended measurement technique.

AN 956-3 Flicker Noise in Schottky Diodes

Treats the subject of flicker (1/f) noise in Schottky diodes, comparing 4 different types.

AN 956-4 Schottky Diode Voltage Doubler

Explains how Schottky detectors can be combined to achieve higher output voltages than would be produced by a single diode.

AN 956-5 Dynamic Range Extension of Schottky Detectors

Discusses operation of two types of detectors: the small signal type, also known as square-law detectors; and the large signal type, also known as linear or peak detectors. Techniques for raising the compression level are presented. An example is given illustrating the effect of bias current level on an HP 5082-2751 detector.

AN 956-6 Temperature Dependence of Schottky Detector Voltage Sensitivity

A discussion of the effects that temperature changes have on Schottky barrier diodes. Performance improves at lower temperatures in a predictable manner. Data presented were obtained using HP 5082-2750 detector diodes.

AN 963 Impedance Matching Techniques for Mixers and Detectors

Presents a methodical technique for matching complex loads, such as Schottky diodes, to a transmission line. Direct application to broadband mixers and detectors is illustrated.

AN 969 An Optimum Zero Bias Schottky Detector Diode

Describes the use of HSCH-3486 zero bias detector diodes. Their forward voltage characteristics are detailed, as well as discussion of voltage sensitivity including effects of junction capacitance, load resistance and reflection loss on sensitivity. Temperature characteristic curves for both devices are also included.

AN 976 Broadband Microstrip Mixer Design, The Butterfly Mixer

A microstrip mixer on RT/duroid substrate is designed for the frequency range 8 GHz to 12 GHz. Hewlett-Packard Schottky barrier diode model 5082-2207 is used. Low impedance shunt transmission lines are difficult to realize and present a problem in this type of circuit. Radial line stubs are used to avoid this problem.

AN 986 Square Law and Linear Detection

Frequency, diode capacitance, breakdown voltage, and load resistance all have an effect on the slope of a microwave detector. At high input levels the linearity may be controlled by proper tuning.

AN 987 Is Bias Current Necessary?

Bias current is often necessary to reduce the impedance of detector diodes to a reasonable level. However, when the

signal level is high, rectified current may reduce the impedance without the need for bias current. Measurements with the 5082-2755 diode are used to illustrate this effect.

AN 988 All Schottky Diodes are Zero Bias Detectors

Diodes which are normally biased make excellent detectors when the bias is eliminated. It is necessary to use a load with an impedance comparable to the diode impedance. This is shown with a 5082-2755 diode used with a 3469B multimeter as the load.

AN 991 Harmonic Mixing with the HSCH-5530 Series Dual Diode

The dual diode on coplanar waveguide forms an anti-parallel pair. This arrangement is excellent for mixers with subharmonic local oscillators. A mixer for 34 GHz was designed and built. Conversion loss was measured as a function of frequency and local oscillator power level.

Hybrid Integrated Circuits Applications

AN 974 Die Attach and Bonding Techniques for Diodes and Transistors

Several package styles are available for use with hybrid integrated circuits. This application note gives detailed instructions for attaching and bonding these devices. A brief description of an impedance matching technique for mixer diodes is also included.

AN 979 The Handling and Bonding of Beam Lead Devices Made Easy

Beam Lead devices are particularly attractive for hybrid circuits because of their low parasitics and small size. The availability of equipment and techniques specifically designed for their small size has facilitated the handling and bonding of these devices. This application note describes some of this equipment and techniques, and outlines suggestions for the proper handling and bonding of Beam Lead devices.

AN 992 Beam Lead Attachment Methods

This application bulletin gives a general description of various methods of attaching beam lead components to both hard and soft substrates. A table summarizes the most common attachment methods with advantages, disadvantages, and equipment costs.

AN 993 Beam Lead Diode Bonding to Soft Substrate

The hard gold surface on standard pc boards with soft substrate material makes it almost impossible to successfully bond beam lead diodes onto the boards with normally recommended thermocompression bonding. Described in this application note is a new method of resistive spot welding or modified gap welding, which uses a single electrode to weld the beam while the conductor is contacted separately. This method allows tight pressure to be used on the weld probe, resulting in an effective bond without damaging the beam lead device.

NEW AN 995 The Schottky Diode Mixer

A major application of the Schottky diode is the production of the difference frequency when the two frequencies are combined or mixed in the diode. Mixing efficiency is measured by the conversion loss, the ratio of signal input power to intermediate frequency output power. This application note studies the effect on mixing efficiency of diode parasitics, local oscillator power level, DC bias, barrier voltage, and local resistance. The advantage of multiple diode mixers are considered. Distortion products are also discussed.

NEW AN 997 A 2 GHz Balanced Mixer Using SOT-23 Surface Mount Schottky Diodes

The HSMS-2822 is a series diode pair in the SOT-23 package — ideal for use in a balanced mixer. The microstrip matching circuit consists of open stubs between the diodes and the I.F. port.

AB 5 Current Source for Diode Testing

This application bulletin describes a constant current source designed primarily for the ease of use in laboratory measurements. Easily programmable by thumb wheel switching in 10 μA steps from 10 μA to 700 mA, its accuracy exceeds most commercially available current sources.

AB 7 Mixer Distortion Measurements

Describes the measurement of distortion in a balanced mixer by the two tone method.

AB 13 Transistor Speed Up Using Schottky Diodes

Significant reduction in transistor switching delay time can be achieved by adding a Schottky diode and a PIN diode to the transistor switching circuit. This improvement in switching performance also extends the oscillator capability of the transistor to higher frequencies.

AB 14 Waveform Clipping with Schottky Diodes

Consideration is given in this application bulletin to the design requirements of clipping circuits which are used to limit the transmission of signals above or below specified levels. The characteristics of Schottky diodes needed to achieve the required performance in these circuits are discussed and recommendations made.

AB 15 Waveform Clamping with Schottky Diodes

Discussed in this application bulletin are the circuit design and diode performance requirements for a clamping circuit, which is used as a DC restorer or level shifter. Schottky diodes having the required characteristics for this type of circuit are recommended.

AB 16 Waveform Sampling with Schottky Diodes

This application bulletin discusses the design considerations for a sampling circuit used to sample high frequency repetitive signals and reproduce them at lower frequencies for ease of monitoring. Schottky diode performance requirements important in the realization of a sampling circuit are considered.

AB 26 Using the HSCH-1001 Schottky Diode for Interfacing in Microprocessor Controlled A/D Conversion Circuits

The use of custom codec (coder/decoder) IC chips simplifies the analog to digital circuitry in microprocessor controlled digital switching circuits. This application bulletin describes the use of the HSCH-1001 Schottky diode to achieve the required compatible interface between the codec chip and the rest of the circuit in order to realize optimum circuit performance.

AB 27 Using the HSCH-1001 Schottky Diode in an AGC Detector Circuit

A detector circuit such as one used for AGC or video detection simply realized with the use of the HSCH-1001 Schottky diode is described in this application bulletin.

AB 28 Optocoupler Speedup using the HSCH-1001 Schottky Diode

An optocoupler typically contains a transistor in the output circuit. When the optocoupler is turned on, the transistor is usually in the saturated state, which means the turn-off time will be unnecessarily long. This application bulletin describes how the HSCH-1001 Schottky diode can be used to alleviate the saturation effects on the transistor and thus improve switching time.

AB 30 Using the 5082-2835 Schottky Diode for Protecting and Improving the Performance of an Operational Amplifier

High level voltage spikes degrade the performance of an operational amplifier, and, in extreme cases, destroy the amplifier permanently. This application bulletin describes how the 5082-2835 Schottky diode can be used to protect an operational amplifier against high level voltage overload, and also to improve output response.

AB 31 Using the HSCH-1001 Schottky Diode in a Data Terminal Memory

The simplicity in a read only memory (ROM) circuit allows the circuit to be large in terms of storage capacity. A large capacity requires a large matrix of active devices. The use of HSCH-1001 Schottky diodes in a ROM circuit can ease the power drain because of their low forward voltage. The use of discrete circuit elements offers ease of repair and modification. These and other important considerations are discussed in this application bulletin.

AB 36 Using the HSCH-1001 Schottky Diode in a Digital Logic Gate

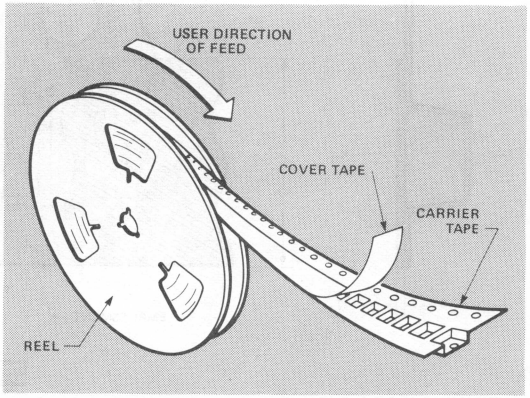
Simple "and" and "or" gates consisting of diodes and resistors can be combined into circuits which will perform increasingly complex functions. The achievement of low loss when the diode is biased on and of high isolation when the diode is biased off are the principal characteristics of these types of logic gates. This application bulletin describes how the HSCH-1001 Schottky diode is particularly suited for this type of application because of its low forward voltage and other inherent characteristics.

HEWLETT PACKARD

TAPE AND REEL PACKAGING FOR SURFACE MOUNT DEVICES

Description

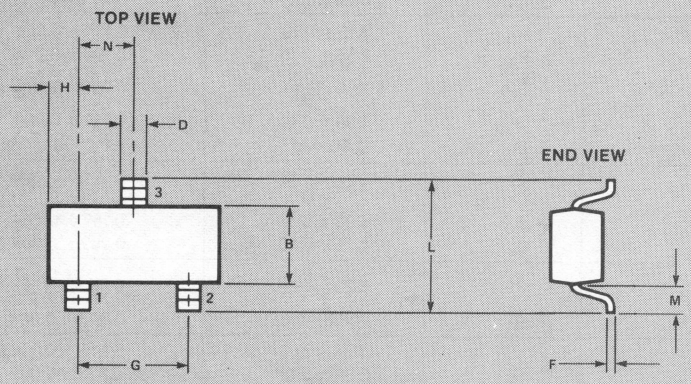
This data sheet is intended to cover standards on tape packaging for Hewlett-Packard Microwave Semiconductor Division (MSD) surface mountable diodes and transistors in the small outline transistor (SOT) rectangular configuration. This type of tape packaging is designed to be compatible with available automated pick and place machines.



Related Standard

EIA RS481, "Taping of Leadless Components for Automatic Placement". In case of conflict regarding MSD product, this data sheet will govern.

1. Dimensions of Bulk Device

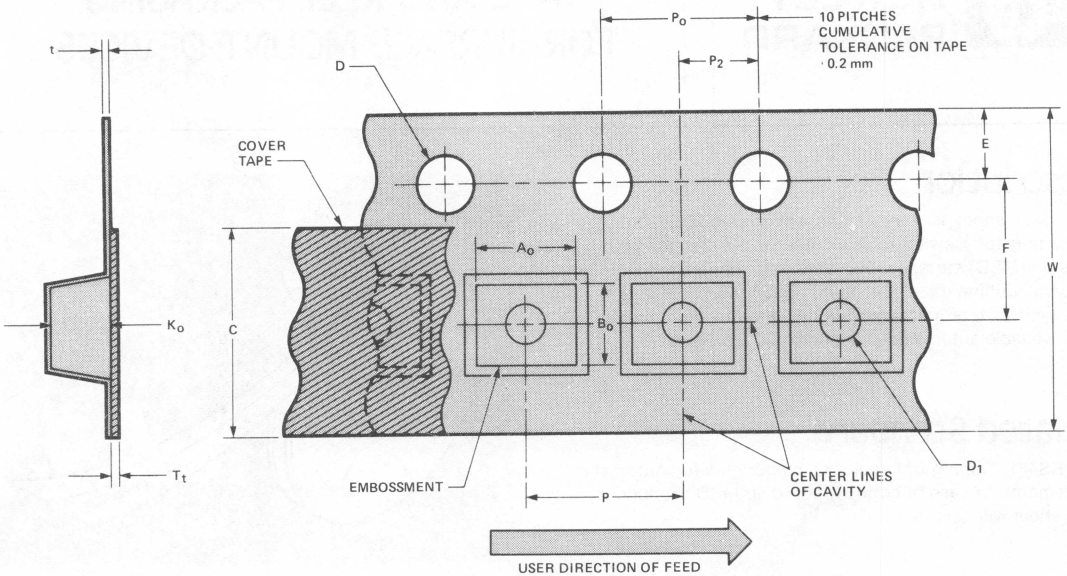


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.06	0.110	0.120
B	1.20	1.40	0.047	0.055
C*	0.85	1.20	0.033	0.047
D	0.37	0.45	0.015	0.018
F	0.086	0.152	0.003	0.006
G	1.78	2.04	0.070	0.080
H	0.45	0.60	0.018	0.024
K*	0.10	0.25	0.004	0.010
L	2.10	2.50	0.083	0.098
M	0.45	0.60	0.018	0.024
N	0.89	1.02	0.035	0.040

NOTE: MEETS ALL JEDEC DIMENSIONAL REQUIREMENTS FOR TO-236AA/AB*
*LOW PROFILE OPTION:
WITH C MIN/MAX OF 0.89/1.04 MILLIMETERS, 0.035/0.041 INCHES;
WITH K MIN/MAX OF 0.013/0.10 MILLIMETERS, 0.0005/0.004 INCHES.

Outline 23

2. Tape Dimensions

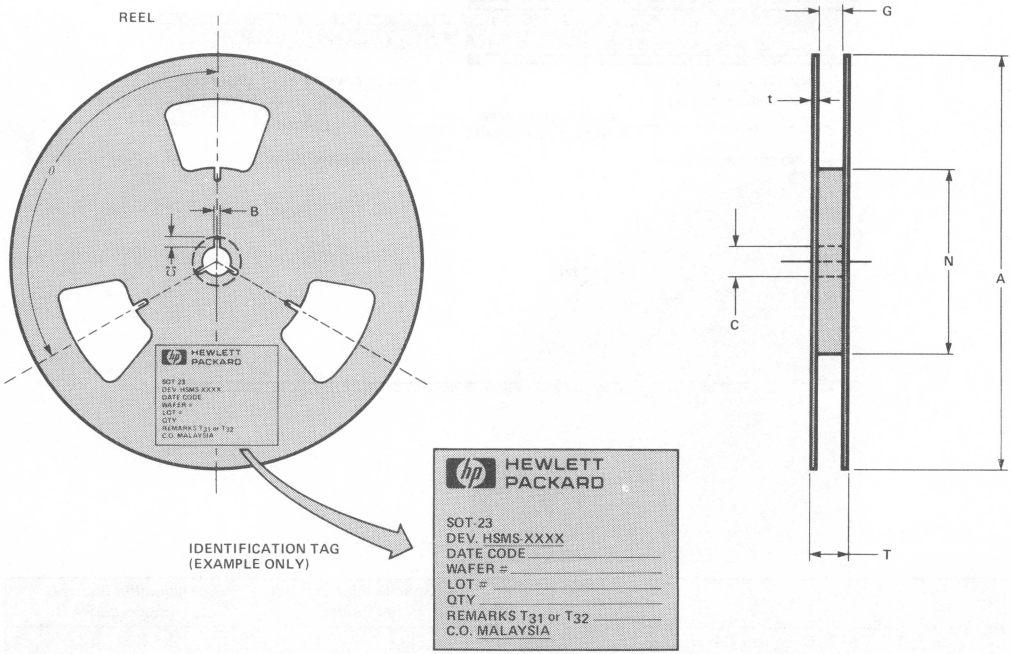


Item		Symbol	Size (mm)	Size (inches)
Cavity	Length	A_o	3.15 ± 0.10	0.124 ± 0.004
	Width	B_o	2.55 ± 0.10	0.100 ± 0.004
	Depth	K_o	$1.50 \begin{smallmatrix}+0.10\\-0\end{smallmatrix}$	$0.059 \begin{smallmatrix}+0.004\\-0\end{smallmatrix}$
	Pitch	P	4.00 ± 0.10	0.157 ± 0.004
	Bottom Hole Diameter	D_1	1.00 min.	0.04 min.
Perforation	Diameter	D	$1.50 \begin{smallmatrix}+0.10\\-0\end{smallmatrix}$	$0.059 \begin{smallmatrix}+0.004\\-0\end{smallmatrix}$
	Pitch	P_o	4.00 ± 0.10	0.157 ± 0.004
	Position	E	1.75 ± 0.10	0.069 ± 0.004
Cover Tape	Width	C	$5.20 \begin{smallmatrix}+0.05\\-0\end{smallmatrix}$	$0.205 \begin{smallmatrix}+0.002\\-0\end{smallmatrix}$
	Tape Thickness	T_t	0.064 ± 0.01	0.003 ± 0.004
Carrier Tape	Width	W	8.00 ± 0.2	0.315 ± 0.008
	Thickness	t	0.30 ± 0.05	0.012 ± 0.002
Distance Between Centerline	Cavity to Perforation (Width Direction)	F	3.50 ± 0.05	0.138 ± 0.002
	Cavity to Perforation (Length Direction)	P_2	2.00 ± 0.05	0.079 ± 0.002

Notes:

1. Metric dimensions will govern.
2. Drawing is not to scale.

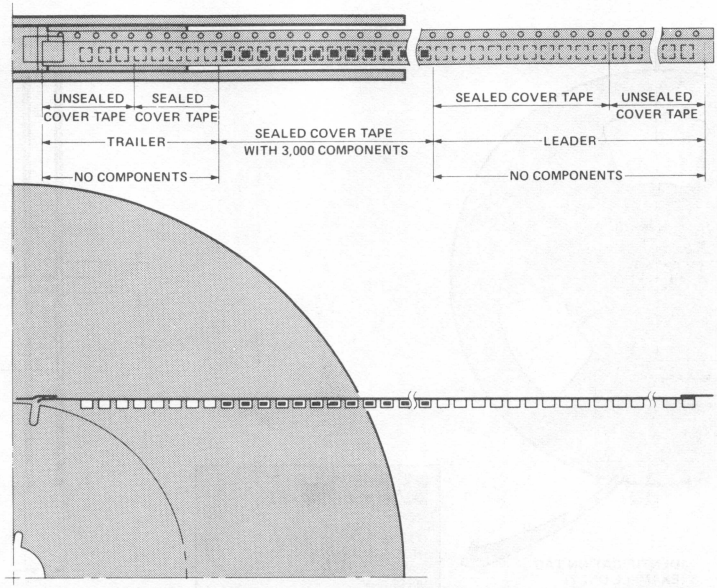
3. Reel Dimensions



Item			Symbol	Size (mm)	Size (inches)
Flange	Diameter		A	178 ± 2.0	7.00 ± 0.079
	Thickness		t	1.5 ± 0.5	0.059 ± 0.020
	Space Between Flange		G	9.50 ± 1.0	0.374 ± 0.040
Hub	Outer Diameter		N	66 ± 1.0	2.598 ± 0.040
	Spindle Hole Diameter		C	13.0 ± 0.2	0.512 ± 0.008
	Key Slit	Width	B	3.0 ± 0.5	0.118 ± 0.020
		Depth	U	5.0 ± 0.5	0.197 ± 0.020
		Location	θ	120° ± 3°	

Notes:
1. Metric dimensions will govern.
2. Drawing is not to scale.

4. Packing — Leader and Trailer



Item		Specification (mm) (minimum)	Specification (inches) (minimum)
Leader	Unsealed Cover Tape	20	0.79
	Sealed Cover Tape with empty cavities	160	6.30
Trailer	Unsealed Cover Tape	20	0.79
	Sealed Cover Tape with empty cavities	120	4.72

5. Materials

A. Carrier Tape:
Semi-conductive: PVC + Carbon
Surface resistivity: 10^7 Ohms per square maximum.

B. Cover Tape:
Polyester (semi-transparent).

C. Reel:
Cardboard

6. Device Orientation and Ordering Information

STANDARD PROFILE

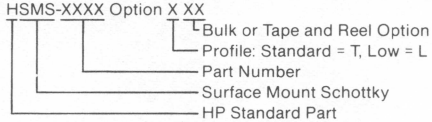
Option T30 = Bulk
Option T31 = Tape and Reel, See Figure 1
Option T32 = Tape and Reel, See Figure 2

LOW PROFILE

Option L30 = Bulk
Option L31 = Tape and Reel, See Figure 1
Option L32 = Tape and Reel, See Figure 2

Conforms to Electronic Industries Standard RS-481 "Taping of Surface Mounted Components for Automated Placement". Standard Quantity is 3,000 Devices/Reel.

Specify: Part Number followed by Option Number.
Example: HSMS-XXXX Option X XX



TOP VIEW END VIEW

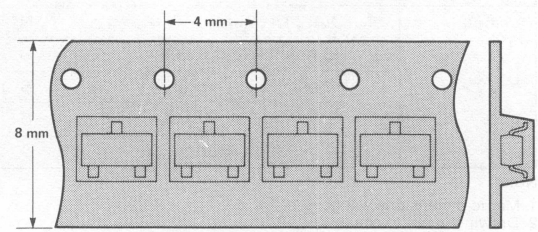


Figure 1.

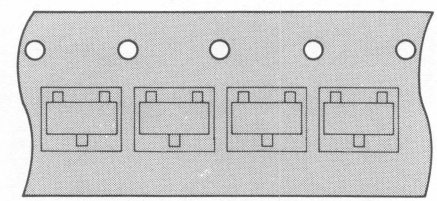
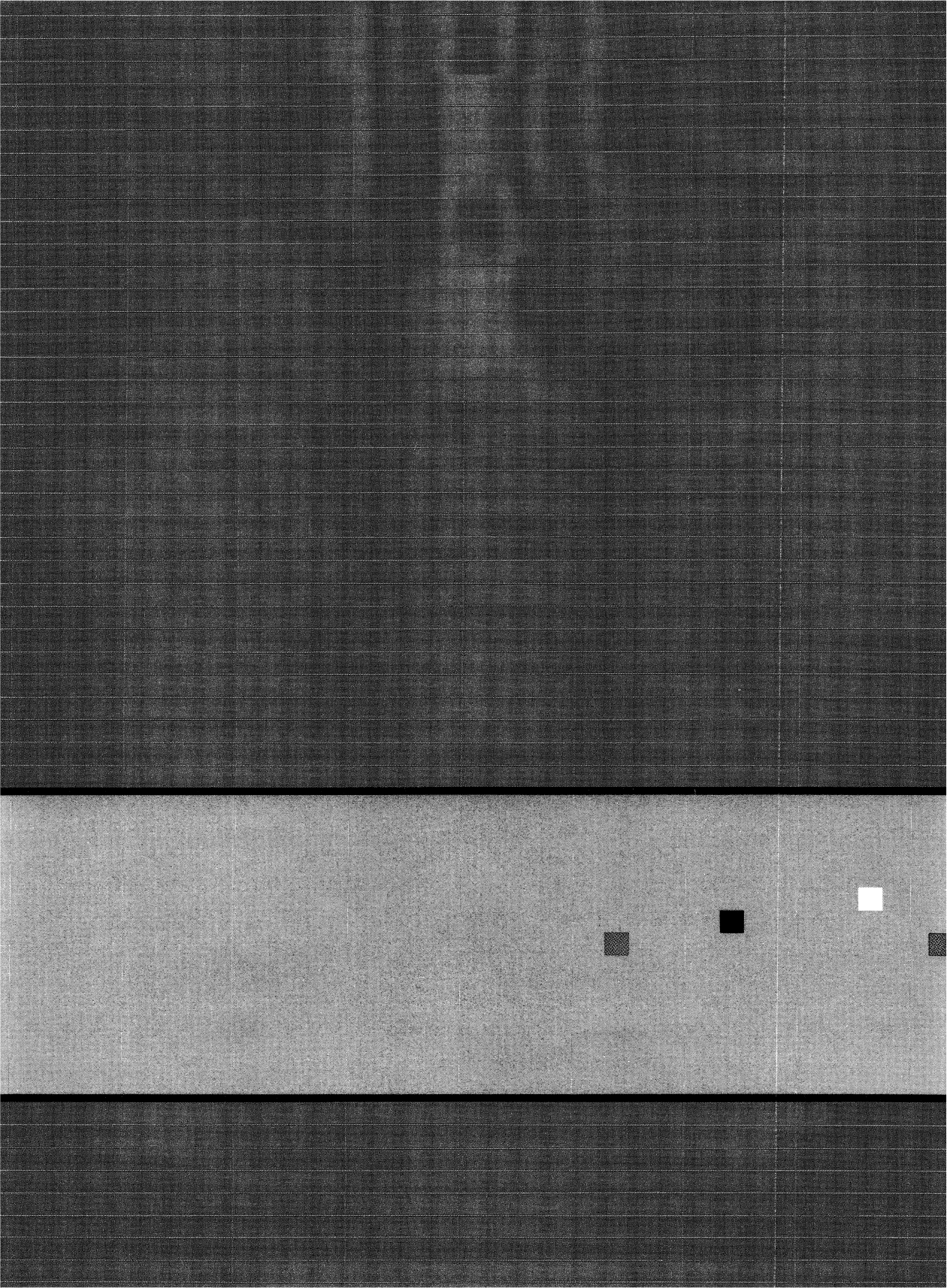
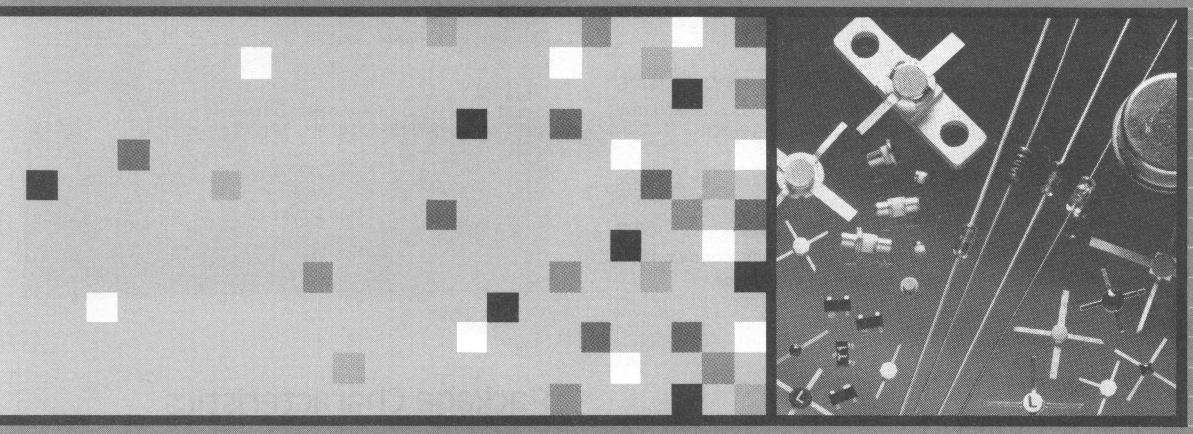


Figure 2.



Switching Diodes

- Packaged Devices 5-2
- Abstracts of Application Notes and Bulletins ..5-12



HEWLETT PACKARD

LOW COST SURFACE MOUNT SCHOTTKY BARRIER DIODES FOR SWITCHING APPLICATIONS

HSMS-2840
HSMS-2841

NEW

Features

SURFACE MOUNT PACKAGE

LOW COST

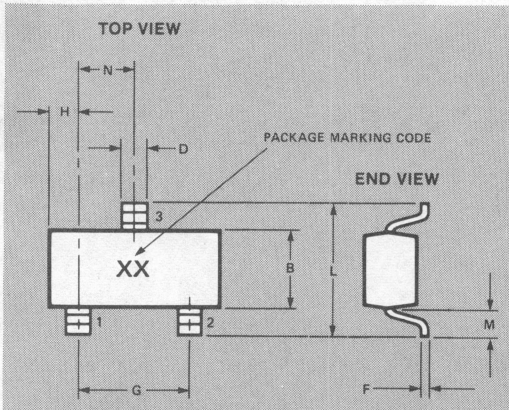
PICO SECOND SWITCHING SPEED

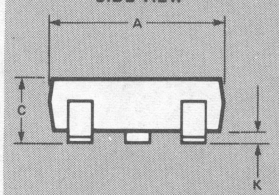
RELIABILITY
- **Silicon Nitride Passivated Chip**
- **Gold Metallized Chip**

LOW FORWARD VOLTAGE DROP

50V BREAKDOWN VOLTAGE

STANDARD AND LOW PROFILE





STANDARD PROFILE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.06	0.110	0.120
B	1.20	1.40	0.047	0.055
C*	0.85	1.20	0.033	0.047
D	0.37	0.45	0.015	0.018
F	0.086	0.152	0.003	0.006
G	1.78	2.04	0.070	0.080
H	0.45	0.60	0.018	0.024
K*	0.10	0.25	0.004	0.010
L	2.10	2.50	0.083	0.098
M	0.45	0.60	0.018	0.024
N	0.89	1.02	0.035	0.040

NOTE: MEETS ALL JEDEC DIMENSIONAL REQUIREMENTS FOR TO-236AA/AB*

*LOW PROFILE also available, with C min/max of 0.89/1.04 millimetres, 0.035/0.041 inches, with K min/max of 0.013/0.10 millimetres, 0.005/0.004 inches.

Outline 23

Description/Applications

The HSMS-284X (in standard or low profile SOT-23 package) is easily surface mountable, and with the tape and reel option is compatible with automatic pick and place systems.

These Schottky diodes are specifically designed for digital and switching applications. Other typical applications of these diodes are clipping, clamping, gating, sampling, wave shaping, and log-amp or A-D converters.

Maximum Ratings

Junction Operating and Storage Temperature Range ..... -65°C to +125°C

DC Power Dissipation ..... 250 mW
(Measured in an infinite heat sink at T_{CASE}=25°C).
Derate linearly to zero at 125°C.

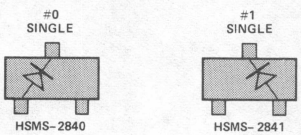
Peak Inverse Voltage (P_{IV}) ..... 50 V

Average Continuous Forward Current ($I_F$avg) ..... Fig. 2

Surge Forward Current (I_F) (1μs pulse) ..... 1 Amp

Operation in excess of any one of these conditions may result in permanent damage to this device.

Package Lead Code Identification



Package Characteristics

Lead Material:	Alloy 42
Lead Finish:	Tin-Lead, 95-5%
Max. Soldering Temperature:	260°C for 5 sec.
Min. Lead Strength:	2 lb. Pull
Typical Package Inductance:	2 nH
Typical Package Capacitance:	0.08 pF (opposite leads)

Electrical Specifications at $T_A = 25°C$

Part Number	Package Marking Code*	Package Outline	Lead Code	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	Maximum Forward Voltage V_F (V) @ I_F (mA)	Maximum Reverse Leakage I_R (nA) @ V_R (V)	Maximum Capacitance C_T (pF)	Maximum Carrier Lifetime τ (pS)
HSMS-2840 HSMS-2841	J0 J1	23 23	0 1	50	410	1.2 10	200 40	2.2	100
Test Conditions				I_R = 10 μA	I_F = 1 mA			V_R = 0 V f = 1 MHz	I = 5 mA Fig. 1

*Package marking code is in white for standard profile.
Package marking code is in orange for low profile.

Switching Time Measurement

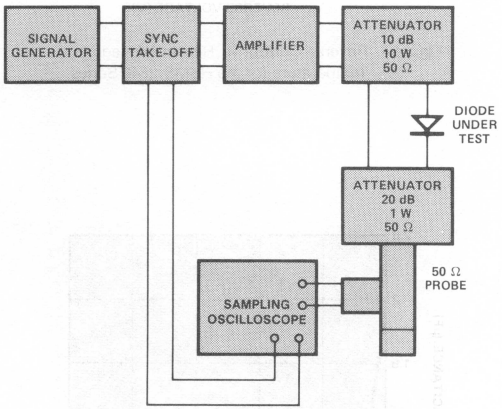


Figure 1a. Test Setup.

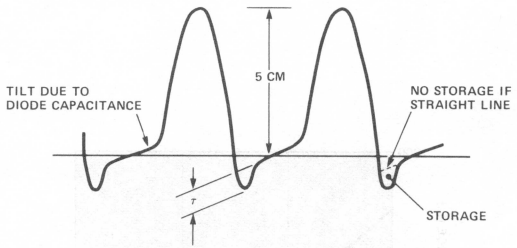


Figure 1b. Resulting Oscilloscope Display.

Figure 1. Effective Minority Carrier Lifetime Measurement.

The signal generator and power amplifier are adjusted to 54 MHz and the output level at 10 V RMS as read on the power amplifier meter. The sampling oscilloscope is adjusted so that the peak deflection corresponding to forward current is 1.25 cm or 5 mA, where 20 mV/cm = 4.0 mA/cm. Under these conditions, minority carrier lifetime is related to the amplitude designated as "τ" such that 1 cm corresponds to 500 ps. This scale will be linear to about 1.5 cm.

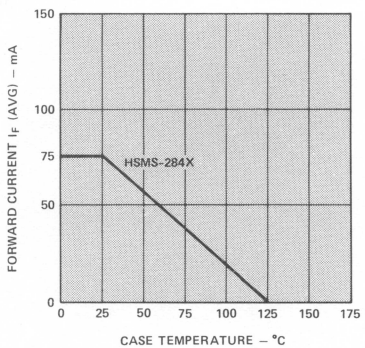


Figure 2.

Typical Parameters at T_A = 25°C (unless otherwise noted)

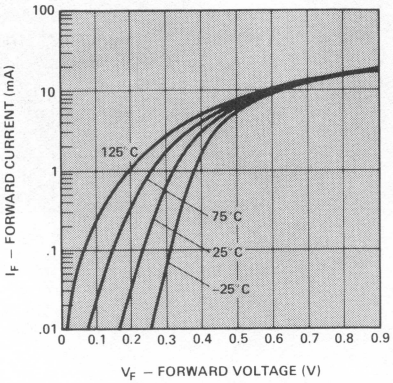


Figure 3. Forward Current vs. Forward Voltage at Temperatures for the HSMS-2840 Series.

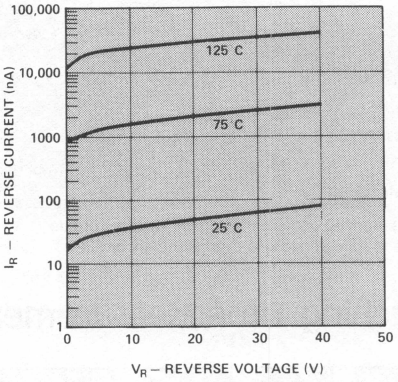


Figure 4. Reverse Current vs. Reverse Voltage at Temperature for the HSMS-2840 Series.

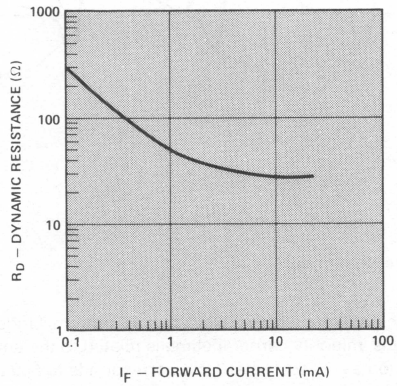


Figure 5. Dynamic Resistance vs. Forward Current for the HSMS-2840 Series.

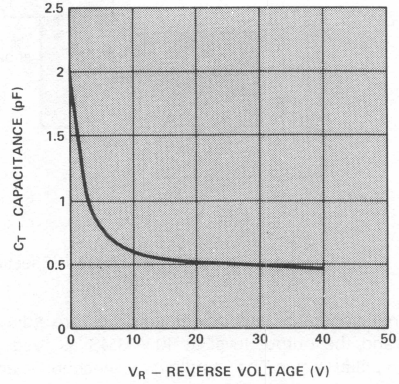


Figure 6. Total Capacitance vs. Reverse Voltage for the HSMS-2840 Series.

Ordering Information

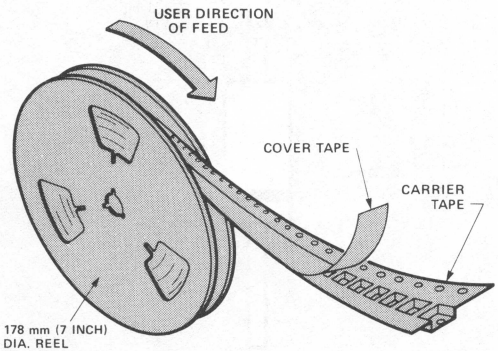
STANDARD PROFILE (White marking)

Option T30 = Bulk
Option T31 = Tape and Reel, See Figure 7
Option T32 = Tape and Reel, See Figure 8

LOW PROFILE (Orange marking)

Option L30 = Bulk
Option L31 = Tape and Reel, See Figure 7
Option L32 = Tape and Reel, See Figure 8

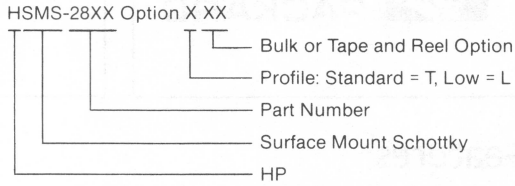
Conforms to Electronic Industries Standard RS-481 "Taping of Surface Mounted Components for Automated Placement". Standard Quantity is 3,000 Devices/Reel.



Please refer to the "Tape and Reel Packaging for Surface Mount Devices" data sheet, publication number 5954-2077, for more detailed information on tape and reel dimensions.

Specify Part Number followed by Option Number.

Example:



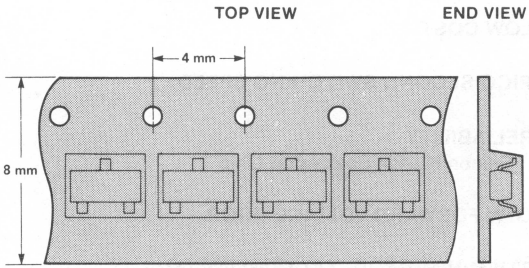


Figure 7. Options T31, L31

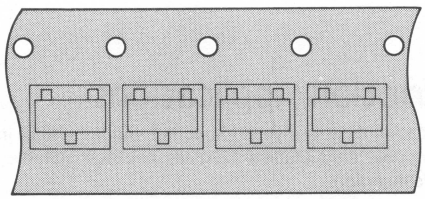


Figure 8. Options T32, L32

HEWLETT PACKARD

LOW COST SCHOTTKY BARRIER DIODES FOR SWITCHING APPLICATIONS

HSCH-1001
(1N6263)

Features

RUGGED DO-35 PACKAGE

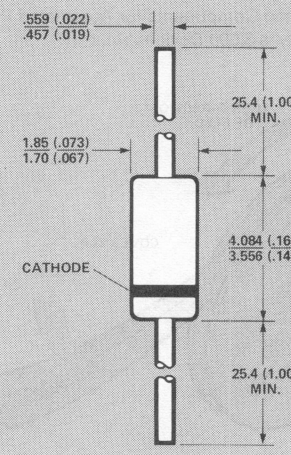
LOW COST

PICO SECOND SWITCHING SPEED

RELIABILITY
Silicon Nitride Passivated Chip

LOW FORWARD VOLTAGE DROP

60 V MINIMUM BREAKDOWN VOLTAGE



DIMENSIONS IN MILLIMETERS (INCHES)

Outline 12 (DO-35)

Description/Applications

The HSCH-1001 is a hybrid Schottky diode sealed in a rugged double stud Outline 12 glass package suitable for automatic insertion.

These Schottky diodes are specifically designed for digital and switching applications. Other typical applications of these diodes are clipping, clamping, gating, sampling, wave shaping, and log-amp or A-D converting.

Maximum Ratings

Junction Operating Temperature ..... -65°C to +150°C
Storage Temperature ..... -65°C to +200° C
DC Power Dissipation ..... 400 mW
(Measured in an infinite heat sink at T_{CASE} = 25°C).
Derate at 2.29 mW/° C to +150°C.
Peak Inverse Voltage (P_{IV}) ..... 60 V
Average Continuous Forward Current ($I_F$avg) ..... Fig. 2

Operation in excess of any one of these conditions may result in permanent damage to this device.

Package Characteristics

Lead Material:	Dumet
Lead Finish:	Tin-Lead 95-5%
Maximum Soldering Temperature:	260°C for 10 seconds
Minimum Lead Strength:	10 lb. Pull
Typical Package Inductance:	1.8 nH
Typical Package Capacitance:	0.25 pF

Note: For Reliability data, see catalog page 4-110.

Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Package Outline	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	V_F = 1 V Max. at Forward Current I_F (mA)	Maximum Reverse Leakage Current I_F (nA)	Maximum Capacitance C_T (pF)	Maximum Carrier Lifetime (psec)
HSCH-1001 (1N6263)	12	60	410	15	200	2.2	100
Test Conditions		$I_R = 10\,\mu A$	$I_F = 1$ mA		$V_R = 50$ V	$V_R = 0$ V f = 1.0 MHz	I = 5 mA See Fig. 1

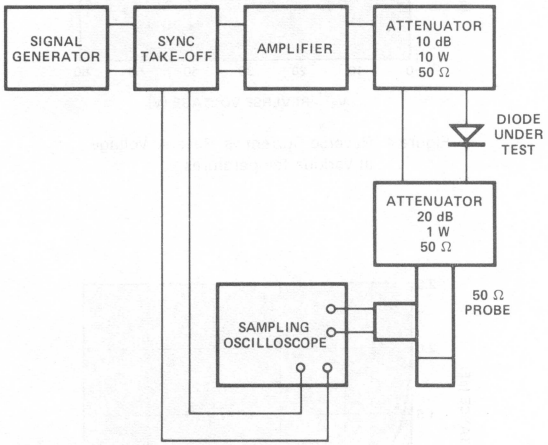


Figure 1a. Test Setup.

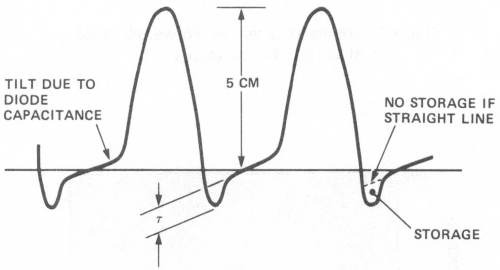


Figure 1b. Resulting Oscilloscope Display.

Figure 1. Effective Minority Carrier Lifetime Measurement.

The signal generator and power amplifier are adjusted to 54 MHz and the output level at 10 V RMS as read on the power amplifier meter. The sampling oscilloscope is adjusted so that the peak deflection corresponding to forward current is 1.25 cm or 5 mA, where 20 mV/cm = 4.0 mA/cm. Under these conditions, minority carrier lifetime is related to the amplitude designated as "τ" such that 1 cm corresponds to 500 ps. This scale will be linear to about 1.5 cm.

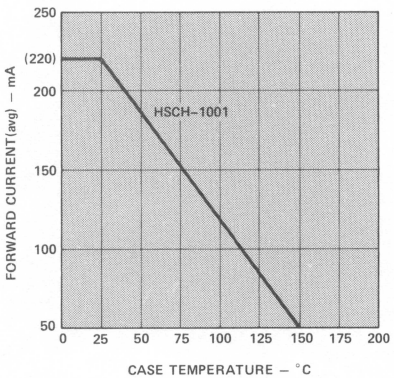


Figure 2. Average Forward Current Temperature Derating Curve.

Typical Parameters at T_A = 25°C (unless otherwise noted)

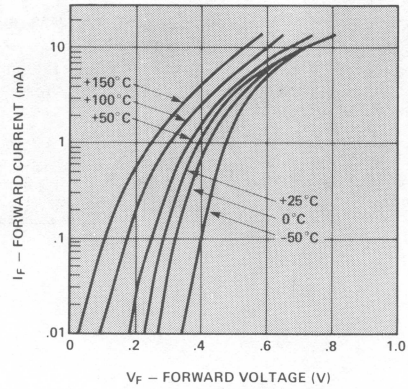


Figure 3. Forward Current vs. Forward Voltage at Various Temperatures.

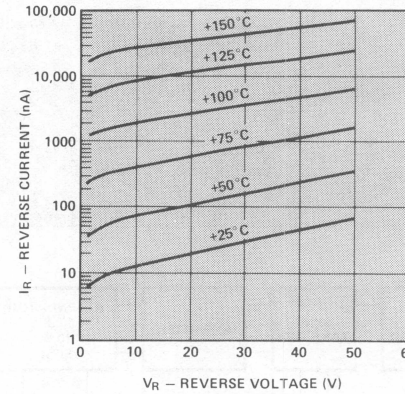


Figure 4. Reverse Current vs. Reverse Voltage at Various Temperatures.

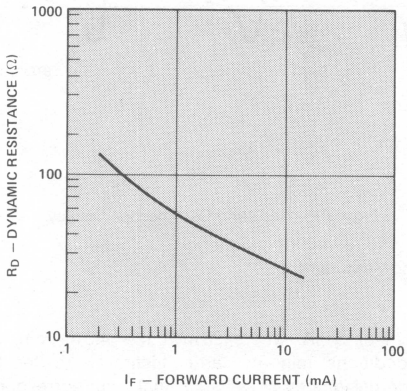


Figure 5. Dynamic Resistance vs. Forward Current.

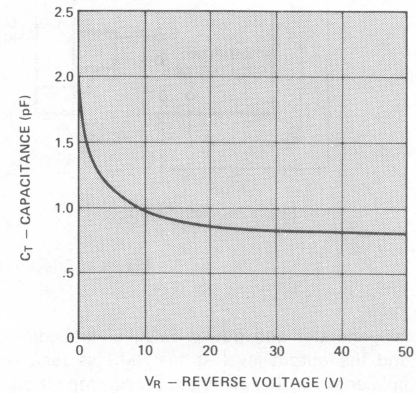


Figure 6. Capacitance vs. Reverse Voltage.

HEWLETT PACKARD

HIGH CONDUCTANCE DIODES

5082-1001
5082-1002
5082-1006

Features

FAST SWITCHING

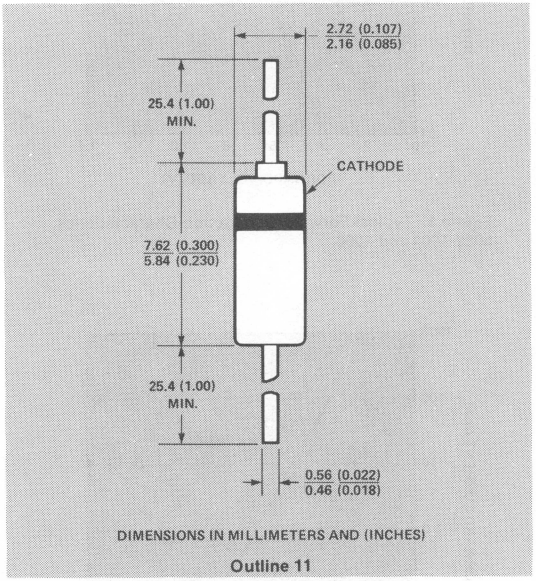
LOW CAPACITANCE

HIGH CURRENT CAPABILITY

Description/Applications

The 5082-1000 series of diodes feature planar silicon epitaxial construction to provide high conductance, low capacitance, and nanosecond turn-on and turn-off. Turn-on time and voltage overshoot are minimized in these diodes of low conductivity modulation.

These diodes are ideally suited for applications such as core drivers, pulse generators, input gates or wherever high conductance without loss of speed is required.



Outline 11

Maximum Ratings

WIV — Working Inverse Voltage
1006 ..... 40 Volts
1001/1002 ..... 30 Volts
I_F (Surge) — Forward Current Surge, 1.0 Second Duration ..... 0.75 Amp
I_F (Surge) — Forward Current Surge, 1.0 Microsecond Duration ..... 7.50 Amp
Power Dissipation[1] @ $T_{CASE} = 25°C$ ..... 500 mW
Operating Temperature Range ..... −65°C to +175°C
Storage Temperature Range ..... −65°C to +200°C

Mechanical Specifications

The HP Outline 11 package has a glass hermetic seal with dumet leads. The package will meet MIL-STD-750, Method 2036, Condition A (2 lbs. tension for 15 sec.) and E. The maximum soldering temperature is 230°C for 5 seconds. Outline 11 package capacitance and inductance are typically 0.15 pF and 4 nH respectively.

Switching Diodes

Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Minimum Breakdown Voltage V_{BR} (V)	Minimum Forward Current I_F (mA)	Minimum Forward Current I_F (mA)	Maximum Reverse Leakage Current I_R (nA)	Maximum Reverse Leakage Current I_R (μA)	Maximum Total Capacitance C_T (pF)	Maximum Reverse Recovery Time t_{rr} (ns)	Maximum Turn-On Time t_{on} (ns)
1001	35	150	500	200	200	1.5	1.5	2.5
1002	35	300	800	200	200	3.0	2.0	2.5
1006	50	150	500	200	200	1.1	1.5	—
Test Conditions	I_R=10μA	V_F=1.0V [2]	V_F=1.4V [2]	[3]	150°C[3]	V_R=0V, f=1.0 MHz	(Figure 9)	(Figure 10)

NOTES:
1. Mounted on a printed circuit board in still air.
2. Measured at a repetition rate not to exceed the power dissipation.
3. V_R=35V for 1006; V_R=30V for 1001, 1002.
4. Inductance measured at the edge of the glass package seal is typically 4.0 nH for all devices.
5. Rectification Efficiency is typically 65% for all devices (Figure 8).

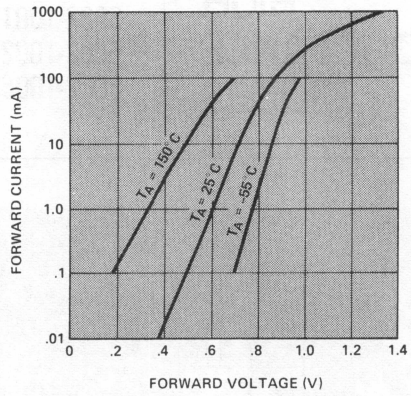


Figure 1. Typical Forward Conduction Characteristics. 5082-1001 and 1006.

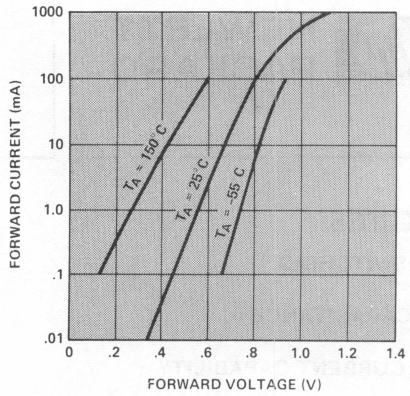


Figure 2. Typical Forward Conduction Characteristics. 5082-1002.

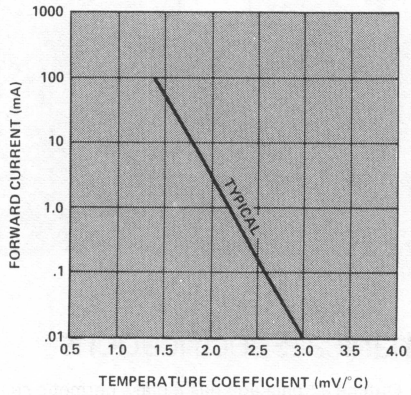


Figure 3. Typical Forward Current Temperature Coefficient.

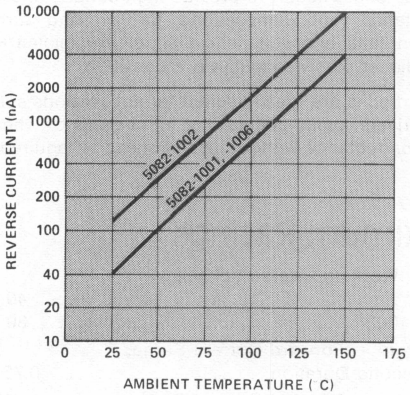


Figure 4. Typical Reverse Current at Specified V_R vs. Increasing Temperature.

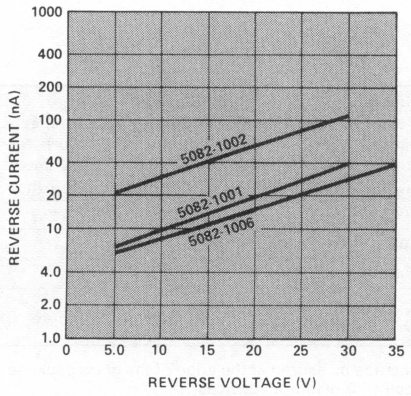


Figure 5. Typical Reverse Current vs. Reverse Voltage.

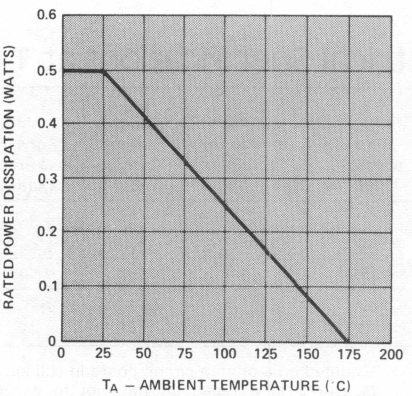


Figure 6. Power Dissipation Derating Characteristics.

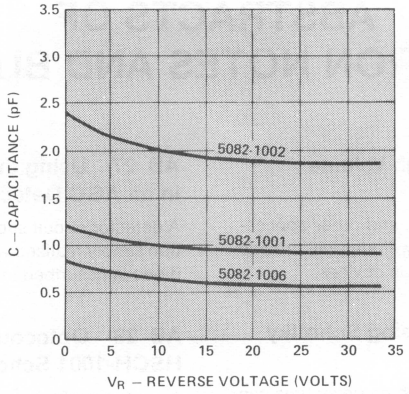


Figure 7. Typical Capacitance vs. Reverse Voltage Characteristics.

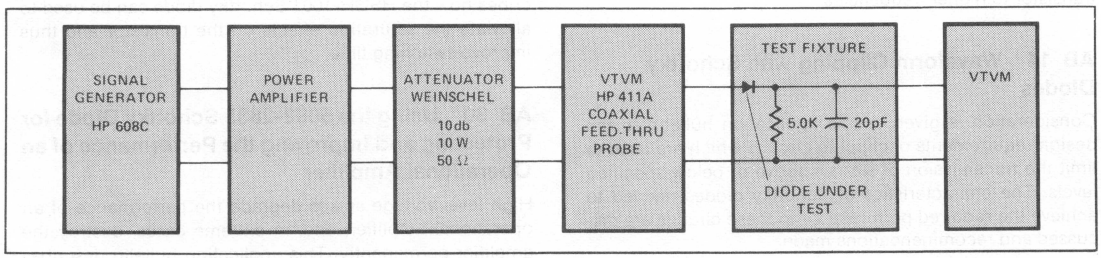


Figure 8. Test Circuit for Measuring the Rectification Efficiency. Signal source is adjusted to 100 MHz and 2V RMS as read on the 411A. The rectification efficiency calculated from the DC output voltage by RE = V_{DC}/2.83 is typically 65% for all devices.

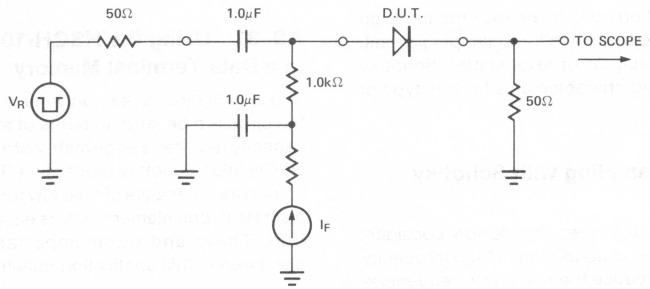


Figure 9. Test Circuit for Measuring Reverse Recovery Time. I_F is set at 20 mA and V_R at 2V.

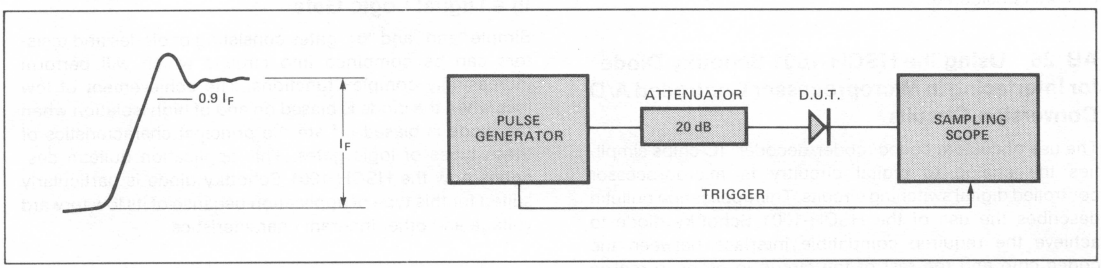


Figure 10. Test Circuit for Measuring Turn-On Time. I_F is adjusted for 10 mA after applying the step voltage. t_{ON} is measured as the time required to reach 0.9 I_F from initial application of the step voltage. For high excitation levels the t_{ON} value is significantly lower than the value specified, i.e., at 100 mA t_{ON} is typically less than 1.0 ns.

ABSTRACTS OF APPLICATION NOTES AND BULLETINS

AN 942 Schottky Diodes for High Volume Low-Cost Applications

Discusses switching, sampling, mixing, and other applications where the substitution of Schottky diodes will provide significant improvement over PN junction devices.

AB 13 Transistor Speed Up Using Schottky Diodes

Significant reduction in transistor switching delay time can be achieved by adding a Schottky diode and a PIN diode to the transistor switching circuit. This improvement in switching performance also extends the oscillator capability of the transistor to higher frequencies.

AB 14 Waveform Clipping with Schottky Diodes

Consideration is given in this application bulletin to the design requirements of clipping circuits which are used to limit the transmission of signals above or below specified levels. The characteristics of Schottky diodes needed to achieve the required performance in these circuits are discussed and recommendations made.

AB 15 Waveform Clamping with Schottky Diodes

Discussed in this application bulletin are the circuit design and diode performance requirements for a clamping circuit, which is used as a DC restorer or level shifter. Schottky diodes having the required characteristics for this type of circuit are recommended.

AB 16 Waveform Sampling with Schottky Diodes

This application bulletin discusses the design considerations for a sampling circuit used to sample high frequency repetitive signals and reproduce them at lower frequencies for ease of monitoring. Schottky diode performance requirements important in the realization of a sampling circuit are considered.

AB 26 Using the HSCH-1001 Schottky Diode for Interfacing in Microprocessor Controlled A/D Conversion Circuits

The use of custom codec (coder/decoder) IC chips simplifies the analog to digital circuitry in microprocessor controlled digital switching circuits. This application bulletin describes the use of the HSCH-1001 Schottky diode to achieve the required compatible interface between the codec chip and the rest of the circuit in order to realize optimum circuit performance.

AB 27 Using the HSCH-1001 Schottky Diode in an AGC Detector Circuit

A detector circuit such as one used for AGC or video detection simply realized with the use of the HSCH-1001 Schottky diode is described in this application bulletin.

AB 28 Optocoupler Speedup using the HSCH-1001 Schottky Diode

An optocoupler typically contains a transistor in the output circuit. When the optocoupler is turned on, the transistor is usually in the saturated state, which means the turn-off time will be unnecessarily long. This application bulletin describes how the HSCH-1001 Schottky diode can be used to alleviate the saturation effects on the transistor and thus improve switching time.

AB 30 Using the 5082-2835 Schottky Diode for Protecting and Improving the Performance of an Operational Amplifier

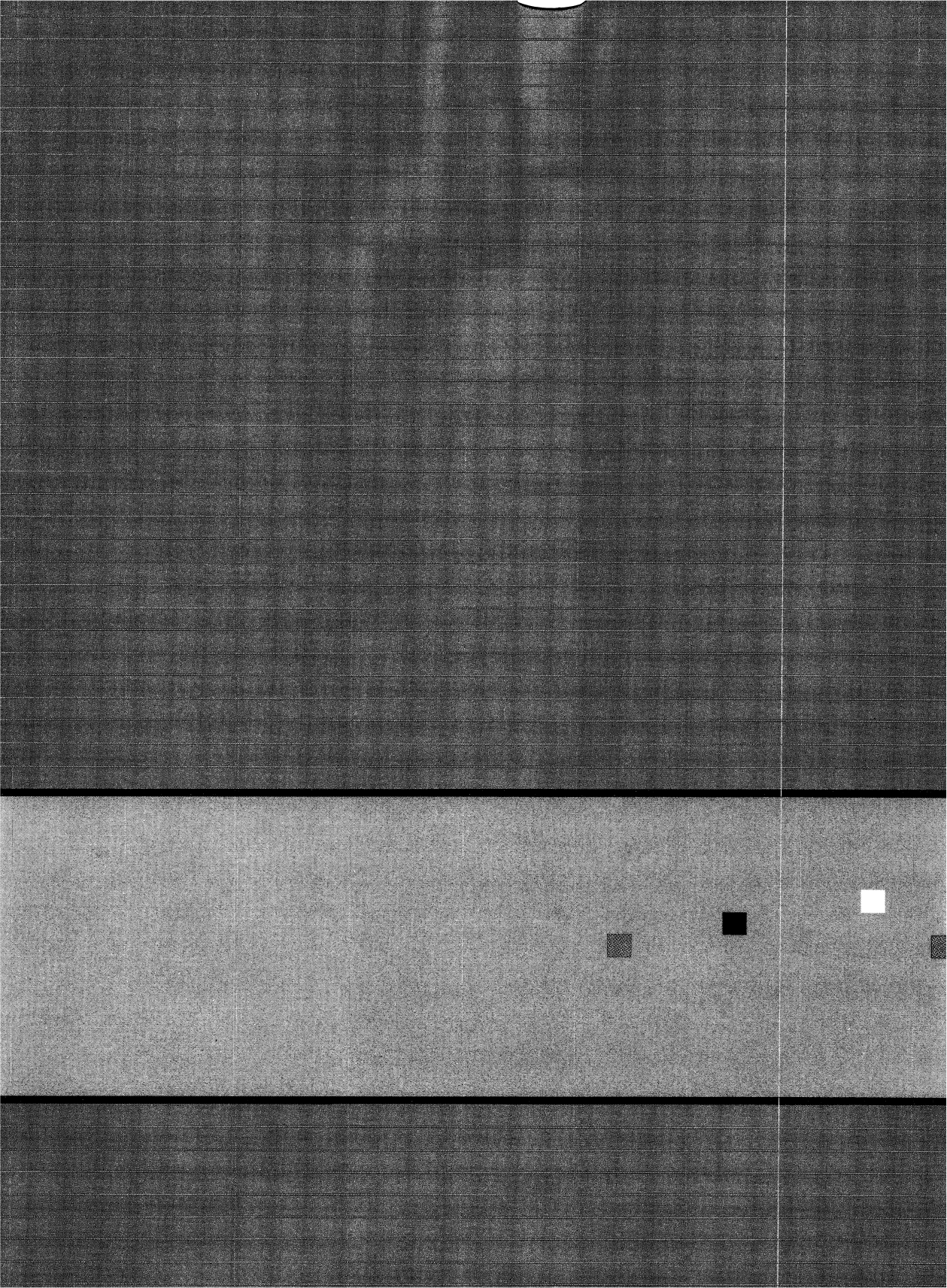
High level voltage spikes degrade the performance of an operational amplifier, and, in extreme cases, destroy the amplifier permanently. This application bulletin describes how the 5082-2835 Schottky diode can be used to protect an operational amplifier against high level voltage overload, and also to improve output response.

AB 31 Using the HSCH-1001 Schottky Diode in a Data Terminal Memory

The simplicity in a read only memory (ROM) circuit allows the circuit to be large in terms of storage capacity. A large capacity requires a large matrix of active devices. The use of HSCH-1001 Schottky diodes in a ROM circuit can ease the power drain because of their low forward voltage. The use of discrete circuit elements offers ease of repair and modification. These and other important considerations are discussed in this application bulletin.

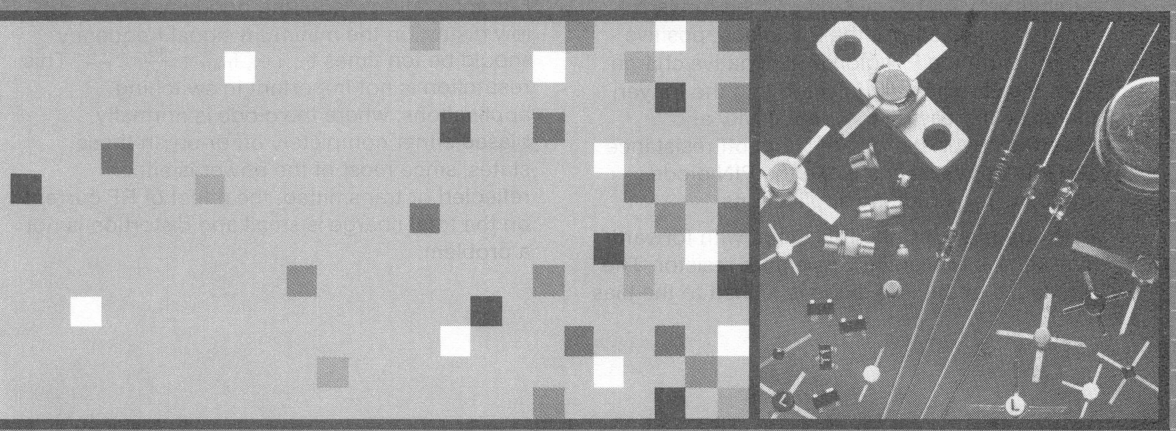
AB 36 Using the HSCH-1001 Schottky Diode in a Digital Logic Gate

Simple "and" and "or" gates consisting of diodes and resistors can be combined into circuits which will perform increasingly complex functions. The achievement of low loss when the diode is biased on and of high isolation when the diode is biased off are the principal characteristics of these types of logic gates. This application bulletin describes how the HSCH-1001 Schottky diode is particularly suited for this type of application because of its low forward voltage and other inherent characteristics.



PIN Diodes

- Characteristics 6-2
- Applications 6-4
- Selection Guide 6-6
- Alphanumeric Index 6-8
- Chips 6-10
- Beam Leads 6-14
- Bonding and Handling Procedures for Beam Lead Diodes 6-24
- Packaged Devices 6-25
- High Reliability Data 6-48
- Reliability Data 6-75
- Abstracts of Application Notes and Bulletins ... 6-84



CHARACTERISTICS OF PIN DIODES

The most important feature of the PIN diode is its basic property of being an almost pure resistor at RF frequencies, whose resistance value can be varied from approximately 10,000 ohms to less than 1 ohm by the control current flowing through it. Most diodes exhibit this characteristic to some degree, but the PIN diode is optimized in design to achieve a relatively wide resistance range, good linearity, low distortion, and low current drive. The characteristics of the PIN diode make it suitable for use in switches, attenuators, modulators, limiters, phase shifters, and other signal control circuits.

Device Characteristics

The principal parameters of a PIN diode which play major roles in determining the performance of a circuit include the following:

RF Resistance

The PIN diode structure consists of an I (Intrinsic) layer of very high resistivity material sandwiched between regions of highly doped P (positively charged) material and N (negatively charged) material. With reverse or zero bias, the I-layer is depleted of charges and the PIN diode exhibits very high resistance. When forward bias is applied across the PIN diode, positive charge from the P region and negative charge from the N region are injected into the I-layer, therefore increasing its conductivity and lowering its resistance. The high off resistance and low on resistance make the PIN diode attractive for switching applications.

At RF frequencies, the PIN diode with forward bias behaves essentially as a pure resistor. The resistance of the PIN diode is related to the bias current, the geometry of the I-layer and the properties of the carriers. For a given type of PIN diode with uniform characteristics, resistance is inversely proportional to the forward bias current. Whereas, only high off resistance and low on resistance are important in switching applications, the resistance characteristics in the entire dynamic range are of concern in attenuator applications. Linearity of resistance with bias makes the PIN diode useful for attenuator applications.

Carrier Lifetime

An important parameter of the PIN diode is the carrier lifetime, τ, which is useful for defining the low frequency limit, $f_O = \frac{1}{2\pi\tau}$, for linear performance of the diode. For RF signal frequencies below f_O, the PIN diode rectifies the signal much like an ordinary PN junction diode, and considerable output distortion results. (See Application Note 957-3 for additional discussion on rectification causes and effects). At frequencies above f_O, less rectification occurs with increasing frequency, allowing the PIN diode to appear more linear, approaching a pure resistor.

For applications requiring good linearity and low distortion the minimum signal frequency should be ten times f_O, i.e., $f_{min} = \frac{10}{2\pi\tau}, = \frac{1.6}{\tau}$. This restriction is not important in switching applications, where the diode is normally biased either completely off or on. In those states, since most of the power is either reflected or transmitted, the effect of RF current on the total charge is small and distortion is not a problem.

Capacitance

Diode capacitance limits switch and attenuator performance at high frequencies in the form of isolation rolloff and increased insertion loss. Optimum performance can be achieved by one of several alternatives available. Using a low capacitance diode would be one solution. Since the junction capacitance of a PIN diode is related to the geometry and electrical properties of the I-layer similar to the case of RF resistance, an R-C trade-off may be feasible. Special techniques can be employed to minimize capacitive (and other parasitic) effects, and in some cases even to take advantage of them. (Some of the techniques for improving high frequency performance are discussed in Application Notes 922 and 957-2.)

Reverse Recovery Time

Reverse recovery time is a measure of switching time, and is dependent on the forward and reverse bias applied. With forward bias current, charge is stored in the I-layer. When a reverse pulse is applied, reverse current will flow for a short period of time, known as delay time, t_d. When a sufficient number of carriers have been removed, the current begins to decrease. The time required for the reverse current to decrease from 90% to 10% is called the transition time, t_t. The sum, $t_d + t_t$, is the reverse recovery time, which is a measure of the time it takes to switch the diode from on to off.

Reverse Breakdown Voltage

The reverse breakdown voltage defines the recommended maximum signal level for safe operation of the diode. Operation at signal levels above the reverse breakdown voltage may result in degradation of diode characteristics or in permanent damage to the diode.

APPLICATIONS OF PIN DIODES

PIN diodes are used principally for the control of RF and microwave signals. Applications include switching, attenuating, modulating, limiting and phase shifting. Certain diode requirements are common to all these control functions, while others are more important in a particular type of usage.

Switching Applications

The performance of a PIN diode circuit is directly related to the basic characteristics of the diode. As an illustrative example, the performance of a PIN diode switch can be simply approximated by treating the PIN diode essentially as a resistor in the forward biased state and a capacitor in the reverse biased state. Switch performance can then be analyzed as follows:

Insertion Loss

The loss of signal attributed to the diode when the switch is on (transmission state) is insertion loss. For low insertion loss, low resistance is needed in a series switch (Figure 1). Low capacitance (particularly at high frequencies) is needed in a shunt switch (Figure 2).

Isolation

Isolation is the measure of RF leakage between the input and output when the switch is off. For high isolation (low transmission) low capacitance is required in a series switch especially at high frequencies (Figure 3). Low resistance is required in a shunt switch (Figure 4).

Switching Speed

In many applications, switching time is very important. Reverse recovery time is a measure of the switching time of a PIN diode, the time required to switch the diode from ON to OFF. The time needed to switch the diode from OFF to ON is shorter. (See Application Note 929 for details).

Power Handling Capability

The RF power (CW or pulse) that can be handled safely by a diode switch is limited by two factors — the breakdown voltage of the diode, and thermal considerations, which involve the maximum junction temperature and the thermal resistance of the diode and packaging. Other factors affecting power handling capability are ambient temperatures, frequency, attenuation level (which is related to diode resistance), pulse width and duty cycle. (See Application Note 922 for details).

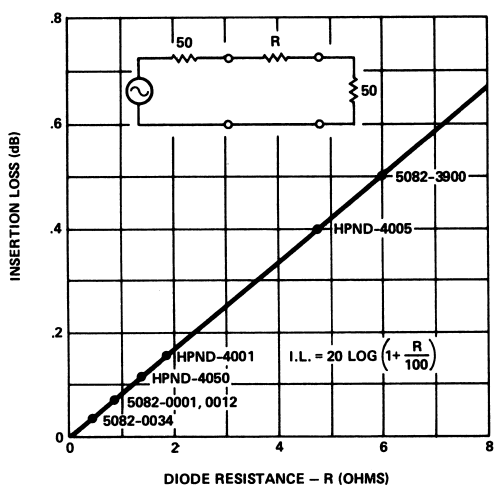


Figure 1. Typical Insertion Loss of Series Diode Switch.

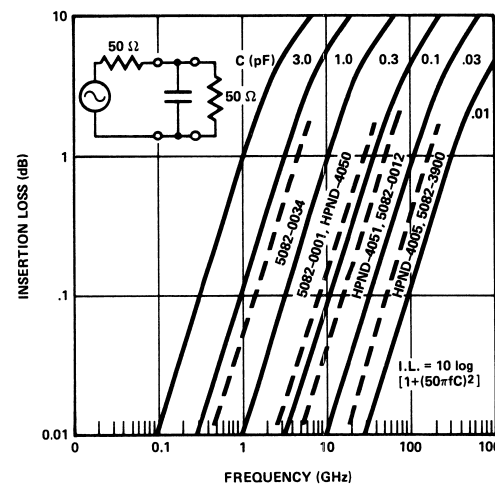


Figure 2. Typical Insertion Loss of Shunt Diode Switch.

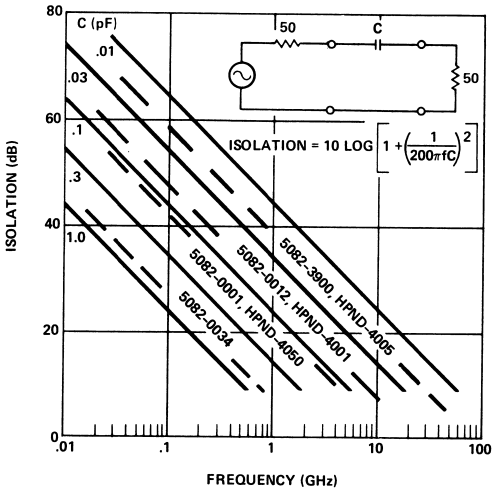


Figure 3. Typical Isolation of Series Diode Switch.

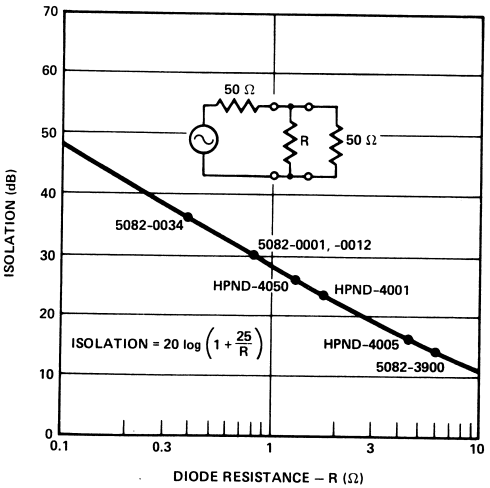


Figure 4. Typical Isolation of Shunt Diode Switch.

Attenuators

Whereas a switch is used only in its maxium ON or OFF state, an attenuator is operated throughout its dynamic range (or resistance range in the case of a diode attenuator). Although a single diode series or shunt switch can be used as an attenuator, it cannot offer in its entire dynamic range constant input and output impedance, which is required for optimum source and load matching in most attenuator applications. By using a multiple diode circuit such as a π, T, or bridged-T attenuator, constant input and output impedance can be achieved throughout the attenuation range.

An additional requirement in most attenuator applications is low distortion. Distortion can be kept at a minimum, if the carrier lifetime of the PIN diode used is greater than the inverse of the signal frequency, preferrably $\tau > \frac{1.6}{f}$, where τ is the carrier lifetime and f is the signal frequency.

Limiters

Sensitive amplifiers, mixers, and detectors in microwave systems can be protected against damage by high level signals with the use of a PIN diode limiter shunting the transmission line.

A PIN diode limiter is essentially an attenuator that uses self bias rather than externally applied bias. As the RF input increases, the rectified current generated by the PIN diode (in some limiter circuits by an auxiliary Schottky diode) biases the diode to a low resistance state. Most of the input power is then attenuated, allowing very little to be transmitted. The sensitive equipment that follows is thus protected.

For a limiter circuit to be efficient, it is essential that the PIN diode has fast switching time. Without an auxiliary diode, a PIN diode with good rectification efficiency is needed to achieve low resistance. Another diode requirement is good heat transfer characteristics (low thermal resistance).

Phase Shifters

The high speed switching capabilities and low ON and high OFF resistance states of the PIN diode make it also very useful for many types of high speed, current controlled phase shifter applications. Another important requirement for these applications is the uniformity of diode characteristics such as capacitance and resistance particularly in systems where a large number of elements are involved.

PIN DIODE SELECTION GUIDE

Hewlett-Packard PIN diodes are available in chip form and several types of packages, which lend themselves more suitable for particular applications. Packaged devices containing the generic chips are listed in the Selection Guide in the order of increasing junction capacitance.

For switching, attenuating, and other general purpose applications particularly in the VHF/UHF range, the low cost glass package (Outline 15) and new surface mount, SOT-23 package are suitable. Due to their low parasitics, ceramic packages (Outlines 31 and 38) are suited for broadband circuits up to 1 GHz and for resonated narrowband circuits up to 8 GHz. In addition, they have medium power handling capability.

Stripline packages (Outlines 60 and 61), containing built-in low pass matching circuits, can be used in broadband designs up to 18 GHz. Because of good heat sinking, they can handle high power in switching, attenuating and limiting applications. The beam lead devices with low parasitics are designed for use in stripline or microstrip circuits using welding or thermo-compression bonding techniques.

(Devices listed in the order of increasing junction capacitance)
All part numbers, 5082- (except HPND-, HSMP- as noted)

Maximum Junction Capacitance C_{JVR} (pF)[1]	Typical RF Resistance R_S (Ω)[2]	Chip	Packaged Devices Containing Similar Chips (Package Outline)						
			Beam Lead	Glass (15)	Ceramic (31)	Ceramic (38)	Stripline (60)	Stripline (61)	SOT-23 (23)
0.02***	4.7††		HPND-4005						
0.025****	6.0†		3900						
0.025*	4.3†††		HPND-4018						
0.045*	2.3†††		HPND-4028						
0.065*	1.5†††		HPND-4038						
0.08*	1.8†††		HPND-4001						
0.12	0.8	0012		3001 3002 3039 3077 1N5719 HPND-4165 HPND-4166	3201 3202	3101 3102	3140	3040	HSMP-3830 HSMP-3831
0.12	0.8	0030			3303 3304		3170	3340	
0.15	0.6	0047							
0.15**	1.3†††		HPND-4050						
0.16**	0.8††	0001		3042 3043	3306	3305	3141	3041 3071	

Notes:
1. All capacitance measured with V_R = 50 volts, except:
   *V_R = 30 volts, **V_R = 20 volts, ***V_R = 10 volts, ****V_R = 0 volt
2. RF resistance measured with I_F = 100 mA, except: †I_F = 50 mA, ††I_F = 20 mA, †††I_F = 10 mA

PIN DIODE SELECTION GUIDE (cont)

(Devices listed in the order of increasing junction capacitance)
All part numbers, 5082- (except HPND-, HSMP- as noted)

Maximum Junction Capacitance C_{JVR} (pF)[1]	Typical RF Resistance R_S (Ω)[2]	Chip	Packaged Devices Containing Similar Chips (Package Outline)						
			Beam Lead	Glass (15)	Ceramic (31)	Ceramic (38)	Stripline (60)	Stripline (61)	SOT-23
0.2	3.5	HPND-0001 HPND-0011							HSMP-3800 HSMP-3801
0.2	2.0	HPND-0002 HPND-0012							HSMP-3810 HSMP-3811
0.20	1.5	0025		3080 3379 1N5767					
0.20	2.0	0039		3081					
1.2**	0.4†††	HPND-0003 HPND-0013							HSMP-3820 HSMP-3821 HSMP-3822 HSMP-3823 HSMP-3824
1.2**	0.4†††	0034		3168 3188					
Package Capacitance (pF)				0.13	0.2	0.2	0.03	0.03	
Pages									

Notes:

1. All capacitance measured with V_R = 50 volts, except:
   *V_R = 30 volts, **V_R = 20 volts, ***V_R = 10 volts, ****V_R = 0 volt
2. RF resistance measured with I_F = 100 mA, except: †I_F = 50 mA, ††I_F = 20 mA, †††I_F = 10 mA

PIN DIODE ALPHANUMERIC INDEX

Part No.	Description	Page Number		
		Commercial Data Sheet	Standard Hi-Rel Data Sheet	Reliability Data Sheet
HPND-0001	Small Signal RF PIN Diode Chip	6-10		6-76
HPND-0002	Small Signal RF PIN Diode Chip	6-10		6-76, 78
HPND-0003	Small Signal RF PIN Diode Chip	6-10		6-76
HPND-4001	Beam Lead PIN Diode	6-14	6-49	
HPND-4005	Beam Lead PIN Diode	6-16	6-51	
HPND-4050	Beam Lead PIN Diode	6-14	6-49	
HPND-4001TXV	Hi-Rel HPND-4001		6-49	
HPND-4005TXV	Hi-Rel HPND-4005		6-51	
HPND-4050TXV	Hi-Rel HPND-4050		6-49	
HPND-4165	RF PIN Diode	6-29		6-82
HPND-4166	RF PIN Diode	6-29		6-82
HPND-4018	Fast Switching Beam Lead PIN Diode	6-18		
HPND-4028	Fast Switching Beam Lead PIN Diode	6-20	6-72	6-76
HPND-4028TXV	Hi-Rel HPND-4028		6-72	
HPND-4038	Fast Switching Beam Lead PIN Diode	6-20	6-72	6-76
HPND-4038TXV	Hi-Rel HPND-4038		6-72	
HSMP-3800	Surface Mount PIN Diode	6-25		
HSMP-3801	Surface Mount PIN Diode	6-25		
HSMP-3810	Surface Mount PIN Diode	6-25		
HSMP-3811	Surface Mount PIN Diode	6-25		
HSMP-3820	Surface Mount PIN Diode	6-25		
HSMP-3821	Surface Mount PIN Diode	6-25		
HSMP-3822	Surface Mount PIN Diode	6-25		
HSMP-3823	Surface Mount PIN Diode	6-25		
HSMP-3824	Surface Mount PIN Diode	6-25		
HSMP-3830	Surface Mount PIN Diode	6-25		
HSMP-3831	Surface Mount PIN Diode	6-25		
JAN 1N5719	MIL-S-19500/443 PIN Diode		6-53	
JANTX 1N5719	MIL-S-19500/443 PIN Diode		6-53	
TXVB-3001	Hi-Rel 5082-3001		6-57	
TXVB-3002	Hi-Rel 5082-3002		6-57	
TXVB-3039	Hi-Rel 5082-3039		6-57	
TXVB-3042	Hi-Rel 5082-3042		6-60	
TXVB-3043	Hi-Rel 5082-3043		6-60	
TXVB-3077	Hi-Rel 5082-3077		6-57	
TXVB-3080	Hi-Rel 5082-3080		6-63	
TXVB-3141	Hi-Rel 5082-3141		6-69	
TXVB-3168	Hi-Rel 5082-3168		6-66	
TXVB-3188	Hi-Rel 5082-3188		6-66	
TXVP-4001	Hi-Rel HPND-4001		6-49	
TXVP-4005	Hi-Rel HPND-4005		6-51	
TXVP-4050	Hi-Rel HPND-4050		6-49	
1N5719	PIN Diode (5082-3039)	6-29		6-82
1N5767	PIN Diode (5082-3080)	6-29		6-80
5082-0001	High Speed Switch PIN Chip	6-12		
5082-0012	PIN Switching Diode Chip	6-12		
5082-0025	AGC PIN Chip	6-12		

PIN DIODE ALPHANUMERIC INDEX (cont)

Part No.	Description	Page Number Commercial Data Sheet	Page Number Standard Hi-Rel Data Sheet	Page Number Reliability Data Sheet
5082-0030	PIN Switching Diode Chip	6-12		
5082-0034	VHF/UHF Switching PIN Chip	6-12		
5082-0039	AGC PIN Chip	6-12		
5082-0047	PIN Switching Diode Chip	6-12		
5082-1001	High Conductance Diode (1N4456)	5-9		
5082-1002	High Conductance Diode	5-9		
5082-1006	High Conductance Diode	5-9		
5082-3001	RF PIN Diode	6-29	6-57	6-82
5082-3002	RF PIN Diode	6-29	6-57	6-82
5082-3039	RF PIN Diode	6-29	6-57	6-82
5082-3040	Stripline PIN Diode	6-35		
5082-3041	Stripline PIN Diode	6-35		
5082-3042	RF PIN Diode	6-29	6-60	
5082-3043	RF PIN Diode	6-29	6-60	
5082-3071	Microwave Limiter PIN Diode	6-33		
5082-3077	VHF/UHF PIN Switching Diode	6-29	6-57	6-82
5082-3080	HF/VHF/UHF Current Controlled Resistor	6-29	6-63	6-80
5082-3081	HF/VHF/UHF Current Controlled Resistor	6-29		
5082-3101	RF PIN Diode	6-46		
5082-3102	RF PIN Diode	6-46		
5082-3140	Hermetic Stripline PIN Diode	6-40		
5082-3141	Hermetic Stripline PIN Diode	6-40	6-69	
5082-3168	VHF/UHF Switching PIN Diode	6-29	6-66	6-80
5082-3170	Hermetic Stripline PIN Diode	6-40		
5082-3188	VHF/UHF Switching PIN Diode	6-29	6-66	6-80
5082-3201	RF PIN Diode	6-46		
5082-3202	RF PIN Diode	6-46		
5082-3303	RF PIN Diode	6-46		
5082-3304	RF PIN Diode	6-46		
5082-3305	High Speed Switch PIN Diode	6-44		
5082-3306	High Speed Switch PIN Diode	6-44		
5082-3340	Stripline PIN Diode	6-35		
5082-3379	VHF/UHF Attenuator PIN Diode	6-29		
5082-3900	PIN Diode Beam Lead	6-22		

HEWLETT PACKARD

SMALL SIGNAL RF PIN DIODE CHIPS FOR HYBRID INTEGRATED CIRCUITS

HPND-0001
HPND-0002
HPND-0003

Features

THERMOCOMPRESSION/THERMOSONICALLY BONDABLE

IDEAL FOR HYBRID INTEGRATED CIRCUITS

GOLD METALLIZATION

SILICON NITRIDE PASSIVATION

UNIFORM ELECTRICAL CHARACTERISTICS

BATCH MATCHED VERSIONS AVAILABLE

PLANAR CONSTRUCTION

Available July '87

Description

These PIN/NIP diode chips are specifically designed for hybrid applications requiring thermosonic or thermocompression bonding techniques. The top metallization is a layer of gold for a tarnish free surface that allows either thermosonic or thermocompression bonding techniques. The bottom metallization is also gold, suitable for epoxy or eutectic die attach method.

Applications

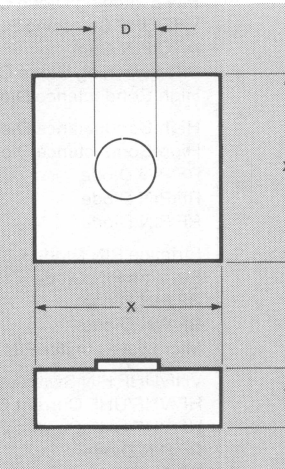
These small signal, general purpose PIN/NIP diode chips are optimized for various analog and digital applications such as switches, digital phase shifters, pulse and amplitude modulators, limiters, leveling, and attenuating.

Maximum Ratings

Junction Operating and Storage Temperature Range ..... -65°C to +150°C

T_A = 25°C

P_D Power Dissipation ..... 250 mW
Measured in an infinite heat sink derated linearly to zero at maximum rated temperature.



DIMENSIONS	FOR EPOXY OR EUTECTIC DIE ATTACH PART NO. HPND-		
	-0001	-0002	-0003
D	10	8	4
X	20	15	12
Y	6	6	5
TOP CONTACT	CATHODE	CATHODE	ANODE
BOTTOM CONTACT	ANODE	ANODE	CATHODE

DIMENSIONS ARE IN 1/1000 INCH.

Operation in excess of any one of these conditions may result in permanent damage to this device.

Electrical Specifications at T_A = 25°C

Chip for Epoxy or Eutectic Die Attach HPND-	Nearest Equivalent 5082 Series Part No. 5082-	Nearest Equivalent Surface Mount Part No. HSMP-	Nearest Equivalent Axial Lead Part No. 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Capacitance C_j (pF)	Typical Parameters		
						Series Resistance R_S (Ω)	Typical Carrier Lifetime T (ns)	Typical Reverse Recovery Time t_{rr} (ns)
0001	0025	3800	3080	100	0.20	3.5	1800	500
0002	--	3810	3081	100	0.20	2.0	1500	300
0003	0034	3820	3188	35	1.2*	0.4*	140*	12
Test Conditions				$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$	V_R = 50 V *V_R = 20 V f = 1.0 MHz	I_F = 100 mA *I_F = 10 mA	I_F = 50 mA I_R = 250 mA *I_F = 10 mA *I_R = 6 mA	I_F = 20 mA V_R = 10 V 90% Recovery

Assembly and Handling Procedures for PIN Chips

1. STORAGE

Devices should be stored in a dry nitrogen purged dessicator or equivalent.

2. CLEANING

If required, surface contamination may be removed with electronic grade solvents such as freon (T.F. or T.M.C.), acetone, deionized water, and methanol used singularly or in combinations. Typical cleaning times per solvent are one to three minutes. DI water and methanol should be used (in that order) in the final cleans. Final drying can be accomplished by placing the cleaned dice on clean filter paper and drying with an infrared lamp for 5–10 minutes. Acids such as hydroflouric (HF), nitric (HNO_3) and hydrochloric (HCl) should not be used.

The effects of cleaning methods/solutions should be verified on small samples prior to submitting the entire lot.

Following cleaning, dice should be either used in assembly (typically within a few hours) or stored in clean containers in a reducing atmosphere or a vacuum chamber.

3. DIE ATTACH

a. Eutectic

Eutectic die attach can be accomplished by "scrubbing" the die without a preform and using the gold on the header to combine with the silicon in the die. Temperature is approximately 400°C, with heating times of 5–10 seconds. (Note—times and temperature utilized may vary depending on the type, composition, and heat capacity of the header or substrate used.) This method is recommended for the HPND-000X series.

b. Epoxy

For epoxy die-attach, conductive silver- or gold-filled epoxies are recommended. This method can be used for all Hewlett-Packard PIN chips.

4. WIRE BONDING

Either ultrasonic or thermocompression bonding techniques can be employed. Suggested wire is pure gold, 0.7 to 1.5 mil diameter.

HEWLETT PACKARD

PIN DIODE CHIPS FOR HYBRID MIC SWITCHES/ATTENUATORS

5082-0001
5082-0012
5082-0025
5082-0030
5082-0034
5082-0047

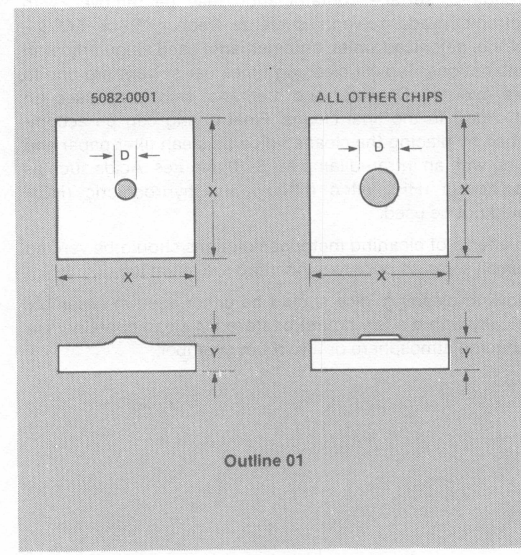
Features

WIDE RANGE OF CAPACITANCE
0.12 pF to 1.2 pF Maximum

LOW SERIES RESISTANCE
0.4 Ω Typical

OXIDE PASSIVATED

WIDE RANGE OF BREAKDOWN VOLTAGE
35 V to 150 V Minimum



Outline 01

Description

These PIN diode chips are silicon dioxide passivated. The 5082-0001 has a mesa construction and the 5082-0025 and -0034 have a planar construction. The 5082-0012, -0030 and -0047 have a pitted planar construction that includes a pit etched into the backside of the chip. The fabrication processes are optimized for long term reliability and tightly controlled for uniformity in electrical performance.

	HP Part Number 5082-				
Dimension	0012 0047	0030	0034	0025	0001
D ±0.03 (1)	0.13 (5)			0.23 (9)	0.06 (2.5)
X ±0.05 (2)	0.38 (15)		0.30 (12)	0.51 (20)	0.38 (15)
Y ±0.03 (1)	0.10 (4.0)		0.13 (5)	0.15 (5)	0.11 (4.5)
Top Contact	Au Cathode	Au Anode	Ag Anode	Ag Cathode	Au Anode
Bottom Contact	Au Anode	Au Cathode		Au Anode	Au Cathode

Dimensions in millimeters (1/1000 inch)

Maximum Ratings

Junction Operating and Storage Temperature Range ..... −65°C to +150°C

Soldering Temperature
5082-0012, -0025, -0030, -0034, -0047 ..... +425°C for one minute maximum
5082-0001 ..... +300°C for one minute maximum

Applications

These general purpose PIN diodes are intended for low power switching applications such as duplexers, antenna switching matrices, digital phase shifters, time multiplex filters, TR switches, pulse and amplitude modulators, limiters, leveling circuits, and attenuators

The 5082-0034 is ideally suited for hybrid VHF/UHF band-switching.

The 5082-0001 is optimized for applications requiring fast switching.

Electrical Specifications at $T_A = 25°C$

Typical Parameters

Chip Part Number 5082-	Nearest Equivalent Packaged Part No. 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Junction Capacitance C_j (pF)	Typical Series Resistance R_S (Ω)	Typical Lifetime τ (ns)	Typical Reverse Recovery Time, t_{rr} (ns)
0012	3001	150	0.12	0.8	400	100
0030	3303	150	0.12	0.8	400	100
0047		150	0.15	0.6	400	100
0001*	3041	70	0.16*	0.8*	35*	5
0025	3080	100	0.20	1.5	1300	1000
0034	3168	35	1.2*	0.4**	70*	12
[*1, 2]	Test Conditions	$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$	$V_R = 50V$ *$V_R = 20V$ f = 1 MHz	$I_F = 100$ mA *$I_F = 20$ mA **$I_F = 10$ mA f = 100 MHz	$I_F = 50$ mA $I_R = 250$ mA *$I_R = 6$ mA *$I_F = 10$ mA	$I_F = 20$ mA $V_R = 10V$ 90% Recovery

Notes:
1. Use standard thermocompression bonding techniques. Ultrasonic bonding is not recommended.
2. Ultrasonic, thermosonic or thermocompression bonding techniques can be employed.

HEWLETT PACKARD

LOW LOSS BEAM LEAD PIN DIODES

HPND - 4001
HPND - 4050

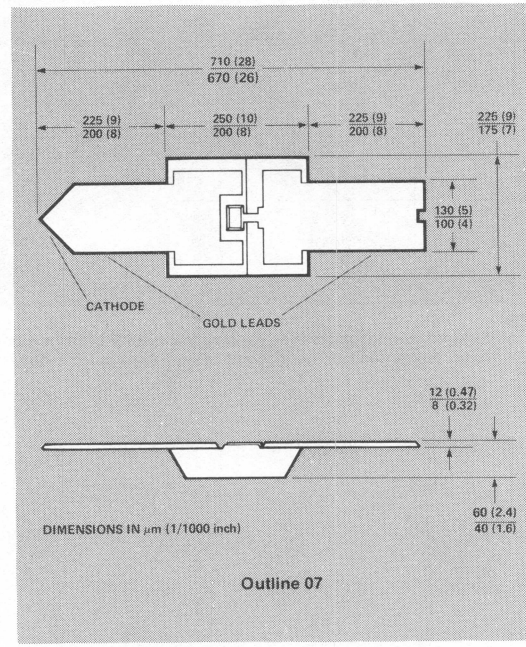
Features

LOW SERIES RESISTANCE
1.3Ω Typical

LOW CAPACITANCE
0.07 pF Typical

FAST SWITCHING
2 ns Typical

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull



Outline 07

Description

The HPND-4001 and -4050 are beam lead PIN diodes designed specifically for low capacitance, low series resistance and rugged construction. The new HP mesa process allows the fabrication of beam lead PINs with a very low RC product. A nitride passivation layer provides immunity from contaminants which would otherwise lead to I_R drift. A polyimide layer provides scratch protection.

Maximum Ratings

Operating Temperature ..... -65°C to +175°C
Storage Temperature ..... -65°C to +200°C
Power Dissipation at T_{CASE} = 25°C ..... 250 mW
(Derate linearly to zero at 175°C)
Minimum Lead Strength ..... 4 grams pull on either lead

Applications

The HPND-4001 and -4050 beam lead PIN diodes are designed for use in stripline or microstrip circuits. Applications include switching, attenuating, phase shifting and modulating at microwave frequencies. The low capacitance and low series resistance at low current make these devices ideal for applications in the shunt configuration.

Bonding and Handling Procedures

See page 6-24.

Electrical Specifications at T_A=25°C

Part Number	Breakdown Voltage V_{BR} (V)		Series Resistance R_S (Ω)		Capacitance C_T (pF)		Minority Carrier Lifetime τ (ns)	Reverse Recovery Time t_{rr} (ns)
	Min.	Typ.	Typ.	Max.	Typ.	Max.	Typ.	Typ.
HPND-4001	50	80	1.8	2.2	0.07*	0.08*	30	3
HPND-4050	30	40	1.3	1.7	0.12	0.15	25	2
Test Conditions	$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$		I_F = 10 mA f = 100 MHz		V_R = 10 V *V_R = 30V f = 1 MHz		I_F = 10 mA I_R = 6 mA	I_F = 10 mA V_R = 10V

Typical Parameters

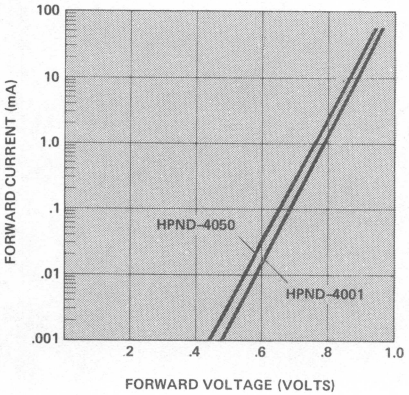


Figure 1. Typical Forward Characteristics.

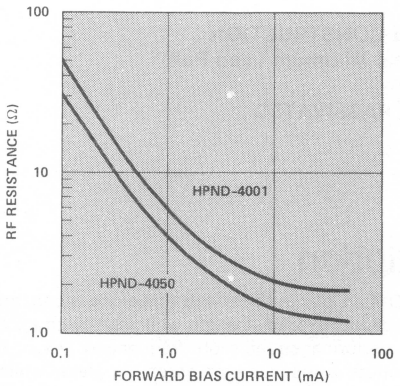


Figure 2. Typical RF Resistance vs. Forward Bias Current.

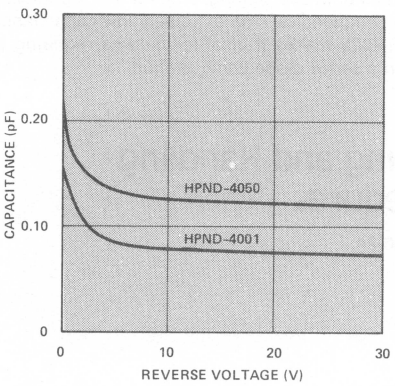


Figure 3. Typical Capacitance vs. Reverse Voltage.

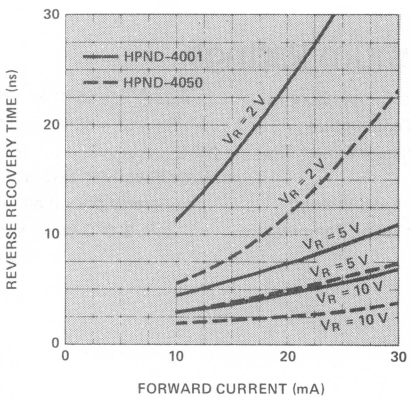


Figure 4. Typical Reverse Recovery Time vs. Forward Current (Shunt Configuration)

HEWLETT PACKARD

BEAM LEAD PIN DIODE

HPND - 4005

Features

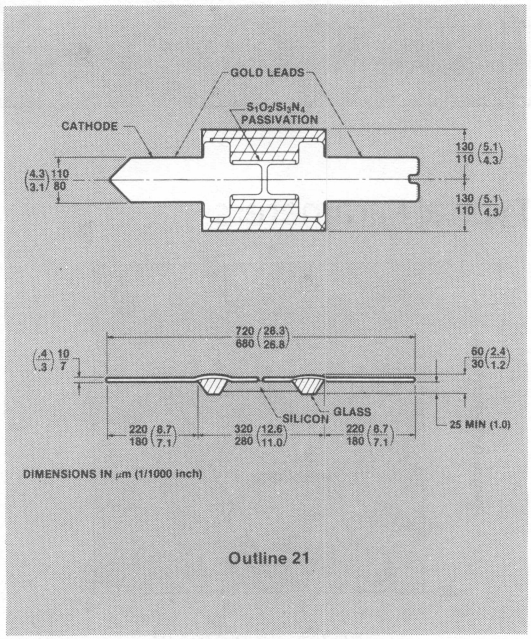
HIGH BREAKDOWN VOLTAGE
120V Typical

LOW CAPACITANCE
0.017 pF Typical

LOW RESISTANCE
4.7Ω Typical

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

NITRIDE PASSIVATED



Outline 21

Description

The HPND-4005 planar beam lead PIN diode is constructed to offer exceptional lead strength while achieving excellent electrical performance at high frequencies. High beam strength offers users superior assembly yield, while extremely low capacitance allows high isolation to be realized.

Nitride passivation and polymide coating provide reliable device protection.

Maximum Ratings

Operating Temperature ..... – 65°C to + 175°C
Storage Temperature ..... – 65°C to + 200°C
Power Dissipation at T_{CASE} = 25°C ..... 250 mW
(Derate linearly to zero at 175° C)
Minimum Lead Strength ..... 4 grams pull on either lead
Diode Mounting Temperature ..... 220°C for 10 seconds maximum

Applications

The HPND-4005 beam lead PIN diode is designed for use in stripline or microstrip circuits. Applications include switching, attenuating, phase shifting, limiting and modulating at microwave frequencies. The extremely low capacitance of the HPND-4005 makes it ideal for circuits requiring high isolation in a series diode configuration.

Bonding and Handling Procedures

See page 6-24.

Electrical Specifications at $T_A = 25°C$

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Breakdown Voltage	V_{BR}	100	120	—	V	I_R = 10 μA
Series Resistance	R_S	—	4.7	6.5	Ohm	I_F = 20 mA, f = 100 MHz
Capacitance	C_T	—	0.017	0.02	pF	V_R = 10 V, f = 10 GHz
Minority Carrier Lifetime	τ	—	100		ns	I_F = 10 mA I_R = 6 mA
Reverse Recovery Time	t_{rr}	—	20	35	ns	I_F = 20 mA V_R = 10 V 90% Recovery

*Total capacitance calculated from measured isolation value in a series configuration.

Typical Parameters

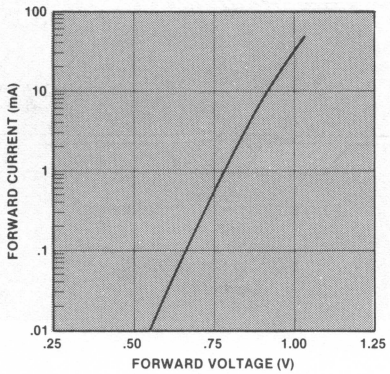


Figure 1. Typical Forward Conduction Characteristics.

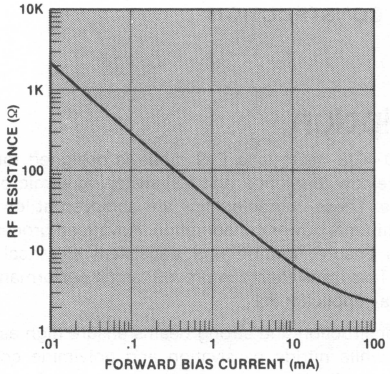


Figure 2. Typical RF Resistance vs. Forward Bias Current.

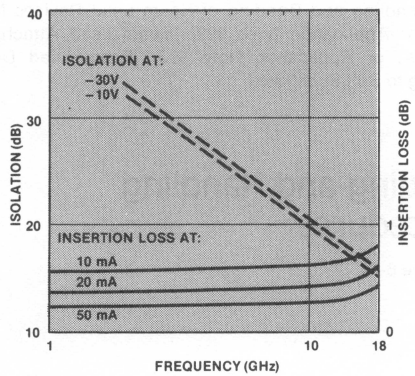


Figure 3. Typical Isolation and Insertion Loss in the Series Configuration ($Z_O = 50\Omega$).

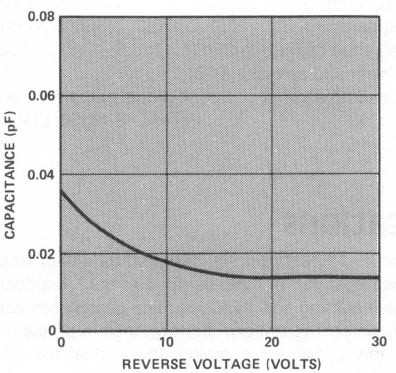


Figure 4. Typical Capacitance at 10 GHz vs. Reverse Bias.

HEWLETT PACKARD

LOW CAPACITANCE FAST SWITCHING BEAM LEAD PIN DIODES FOR PHASED ARRAYS

HPND-4018

Features

LOW CAPACITANCE
0.025 pF Maximum at 1 MHz

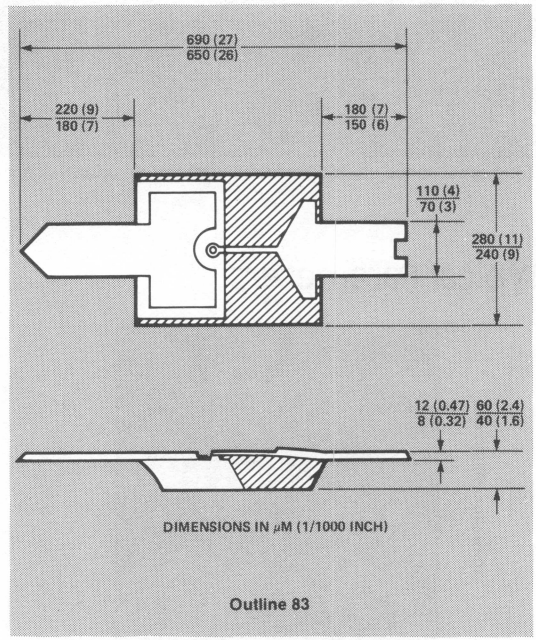
FAST SWITCHING
2.0 nsec Typical

LOW RESISTANCE AT LOW BIAS
4.6 Ohms Max. at I_F = 10 mA

SILICON NITRIDE PASSIVATION

RUGGED CONSTRUCTION

Available June 1987



Description

The HPND-4018 beam lead PIN diode is designed for low capacitance, low resistance, and fast switching at microwave frequencies. These characteristics are achieved at low bias levels for minimal power consumption. Advanced processing techniques ensure uniform and consistent electrical performance. This translates to improved circuit performance in phased array applications.

Rugged construction and strong beams ensure high assembly yields while nitride passivation and polyimide coating ensure device reliability.

Maximum Ratings

Operating Temperature . . . . . -65°C to +150°C
Storage Temperature . . . . . -65°C to +200°C
Power Dissipation at T_{LEAD} = 25°C . . . . . 250 mW
(Derate linearly to zero at 150°C)
Minimum Lead Strength . . . . . 4 grams pull on either lead
Per MIL-S-19500, LTPD = 20

Applications

These beam lead PIN diodes are designed for use in stripline, coplanar waveguide, or microstrip circuits. Applications include phase shifting and switching. The guaranteed capacitance windows ensure uniform performance in phased array radar. The low capacitance makes them ideal for circuits requiring high isolation in the series configuration.

Assembly Techniques

Thermocompression bonding is recommended. Welding, ultrasonic bonding, solder, or conductive epoxy may also be used. For additional information see Application Note 979, "The Handling and Bonding of Beam Lead Devices Made Easy", or Application Note 992, "Beam Lead Attachment Methods", or Application Note 993, "Beam Lead Device Bonding to Soft Substrates".

Bonding and Handling Procedures

See page 6-24.

Electrical Specifications at $T_A = 25°C$

Part Number	Capacitance C_T (pF)		Series Resistance R_S (Ω)		Breakdown Voltage V_{BR} (V)
	Min.	Max.	Typ.	Max.	Min.
HPND-4018	.015	.025	4.3	4.6	60
Test Conditions	V_R = 30 V f = 1 MHz		I_F = 10 mA f = 100 MHz		$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$

Typical Parameters

Carrier Lifetime τ (ns)	Reverse Recovery t_{rr} (ns)	Series Resistance R_S (Ω)
Typ.	Typ.	Typ.
30	2.0	3.0
I_F = 10 mA I_R = 6 mA	I_F = 5 mA V_R = 10 V 90% recovery	I_F = 25 mA f = 100 MHz

HEWLETT PACKARD

FAST SWITCHING BEAM LEAD PIN DIODES FOR PHASED ARRAYS

HPND-4028
HPND-4038

Features

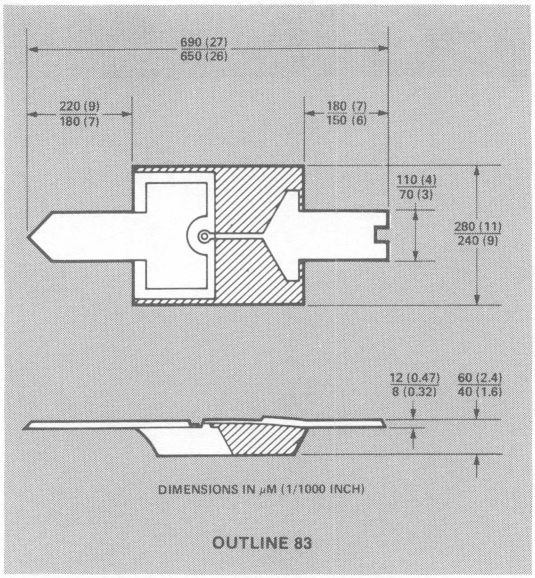
LOW CAPACITANCE
Guaranteed Min/Max

LOW RESISTANCE AT LOW BIAS
1.5 ohms at I_F = 10mA

FAST SWITCHING
2.4 nsec

RUGGED CONSTRUCTION
10 Gram Lead Pull (Typical)

SILICON NITRIDE PASSIVATION



OUTLINE 83

Description

The HPND-4028 and 4038 beam lead PIN diodes are designed for low capacitance, low resistance, and fast switching at microwave frequencies. These characteristics are achieved at low bias levels for minimal power consumption. Advanced processing techniques ensure uniform and consistent electrical performance allowing guaranteed capacitance windows. This translates to improved circuit performance in phased array applications.

Rugged construction and strong beams ensure high assembly yields while nitride passivation and polyimide coating ensure device reliability.

Maximum Ratings

Operating Temperature ..... −65°C to +150°C

Storage Temperature ..... −65°C to +200°C

Power Dissipation at T_{case} = 25°C 250mW
(Derate linearly to zero at 150°C)

Minimum Lead Strength ..... 6 grams pull on either lead
Per MIL-S-19500, LTPD = 20

Applications

These beam lead PIN diodes are designed for use in stripline, coplanar waveguide, or microstrip circuits. Applications include phase shifting and switching. The guaranteed capacitance windows ensure uniform performance in phased array radar. The low capacitance makes them ideal for circuits requiring high isolation in the series configuration.

Assembly Techniques

Thermocompression bonding is recommended. Welding, ultrasonic bonding, solder, or conductive epoxy may also be used. For additional information see Application Note 979, "The Handling and Bonding of Beam Lead Devices Made Easy", or Application Note 992, "Beam Lead Attachment Methods", or Application Note 993, "Beam Lead Device Bonding to Soft Substrates".

Bonding and Handling Procedures

See page 6-24.

Electrical Specifications at Ta = 25°C

Part Number	Capacitance (pF)		Series Resistance R_S (Ω)		Breakdown Voltage (V)
	Min.	Max.	Typ.	Max.	Min.
HPND-4028	.025	.045	2.3	3.0	60
HPND-4038	.045	.065	1.5	2.0	60
Conditions	V_R = 30 V f = 1MHz		I_F = 10 mA f = 100MHz		$V_R = V_{BR}$ Measure $I_R \leq 10\mu A$

Typical Parameters

Carrier Lifetime (ns)	Reverse Recovery (ns)	Series Resistance R_S (Ω)
Typ.	Typ.	Typ.
36	2.6	2.0
45	2.4	1.0
I_F = 10 mA I_R = 6 mA	I_F = 5 mA V_R = 10 V 90% recovery	I_F = 50 mA f = 100MHz

Typical Parameters (Series Configuration)

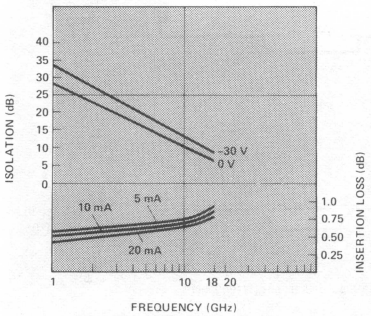


Figure 1. Typical Isolation and Insertion Loss. HPND-4028.

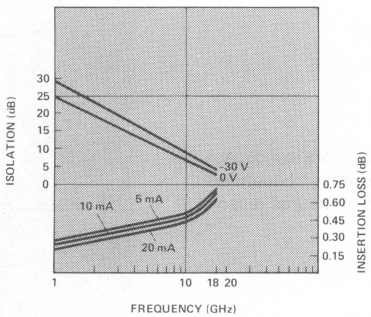


Figure 2. Typical Isolation and Insertion Loss. HPND-4038.

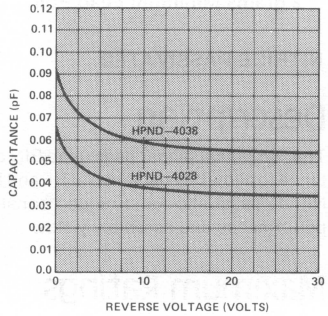


Figure 3. Typical Capacitance vs. Reverse Voltage (at 1 MHz).

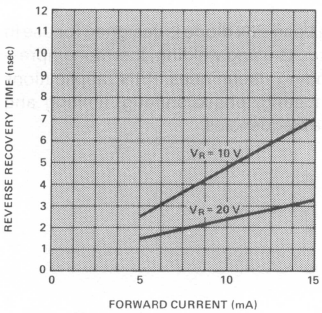


Figure 4. Typical Reverse Recovery Time vs. Forward Current (Series Configuration), HPND-4028, HPND-4038.

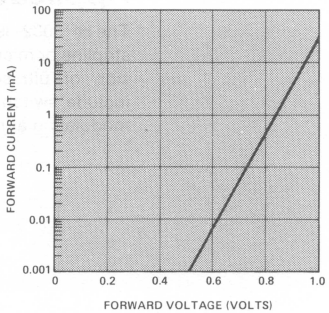


Figure 5. Typical Forward Characteristics, HPND-4028, HPND-4038.

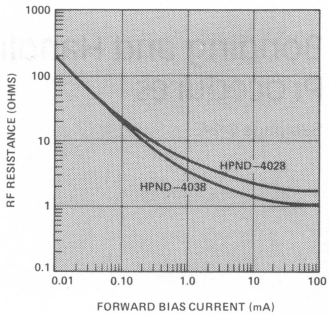


Figure 6. Typical RF Resistance vs. Forward Bias Current (at 100 MHz).

PIN Diodes

HEWLETT PACKARD

BEAM LEAD PIN DIODE

5082-3900

Features

HIGH BREAKDOWN VOLTAGE
200 V Minimum

LOW CAPACITANCE
0.02 pF Typical

RUGGED CONSTRUCTION
2 grams Minimum Lead Pull

NITRIDE PASSIVATED

Description

The 5082-3900 planar beam lead PIN diode offers low capacitance to allow high isolation at RF and Microwave frequencies. Nitride passivation and rugged construction insures reliable performance and assembly yields.

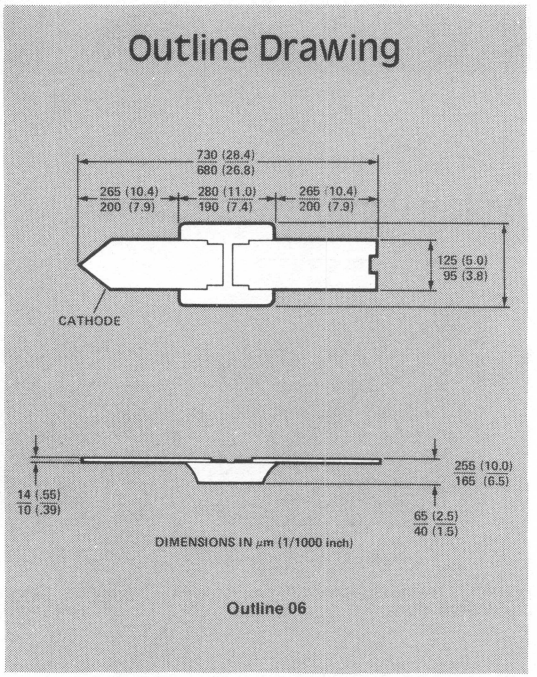
Maximum Ratings

Operating Temperature ..... −60° C to + 150° C
Storage Temperature ..... −60° C to +150° C
Power Dissipation at T_{CASE} = 25° C ..... 250 mW
(Derate linearly to zero at 150° C)
Minimum Lead Strength ..... 2 grams pull on either lead
Diode Mounting Temperature ..... 220° C for 10 sec. max.

Bonding and Handling Procedures

See page 6-24.

Outline Drawing



Outline 06

Applications

The HP 5082-3900 Beam Lead PIN diode is designed for use in stripline or microstrip circuits using welding, thermocompression or ultrasonic bonding techniques. PIN applications include switching, attenuating, phase shifting, limiting and modulating at microwave frequencies.

Electrical Specifications at $T_A = 25°C$

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Breakdown Voltage	V_{BR}	150	200	—	V	$I_R = 10\ \mu A$
Series Resistance	R_S	—	6	8	ohm	$I_F = 50$ mA, f = 100 MHZ
Capacitance	C_O	—	0.02	0.025	pF	V = 0 V, f = 3 GHz
Minority Carrier Lifetime	τ	—	150	—	ns	$I_F = 50$ mA, $I_R = 250$ MHz

Typical Parameters

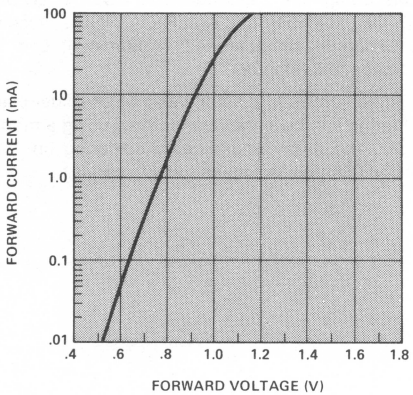


Figure 1. Typical Forward Conduction Characteristics.

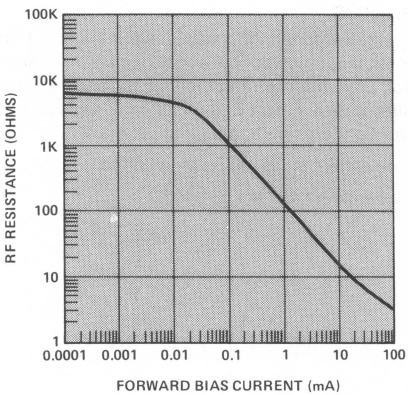


Figure 2. Typical RF Resistance vs. DC Bias Current.

Bonding and Handling Procedures for Beam Lead Diodes

1. STORAGE

Under normal circumstances, storage of beam lead diodes in HP supplied waffle/gel packs is sufficient. In particularly dusty or chemically hazardous environments, storage in an inert atmosphere desiccator is advised.

2. HANDLING

In order to avoid damage to beam lead devices, particular care must be exercised during inspection, testing, and assembly. Although the beam lead diode is designed to have exceptional lead strength, its small size and delicate nature requires that special handling techniques be observed so that the devices will not be mechanically or electrically damaged. A vacuum pickup is recommended for picking up beam lead devices, particularly larger ones, e.g., quads. Care must be exercised to assure that the vacuum opening of the needle is sufficiently small to avoid passage of the device through the opening. A #27 tip is recommended for picking up single beam lead devices. A 20X magnification is needed for precise positioning of the tip on the device. Where a vacuum pickup is not used, a sharpened wooden Q-tip dipped in isopropyl alcohol is very commonly used to handle beam lead devices.

3. CLEANING

For organic contamination use a warm (<75°C) rinse of trichloroethane followed by a cold rinse in acetone and methanol. Dry under infrared heat lamp for 5-10 minutes on clean filter paper. Freon degreaser may replace trichloroethane for light organic contamination.

- Ultrasonic cleaning is not recommended
- Acid solvents should not be used

4. BONDING

Thermocompression: See Application Note 979 "The Handling and Bonding of Beam Lead Devices Made Easy". This method is good for hard substrates only.

Wobble: This method picks up the device, places it on the substrate and forms a thermocompression bond all in one operation. This is described in MIL-STD-883, Method 2017 and is intended for hard substrates only. Equipment specifically designed for beam lead wobble bonding is available from KULICKE and SOFFA in Horsham, PA.

Resistance Welding or Parallel-GAP Welding: To make welding quads easier, attach one electrode of the welder to the substrate and use the second electrode for welding in lieu of the parallel gap electrode. To make welding on soft substrates easier, a low pressure welding head is recommended. Suitable equipment is available from HUGHES, Industrial Products Division in Carlsbad, CA.

Epoxy: With solvent free, low resistivity epoxies (available from ABLESTIK in Gardenia, CA, MICON in Lexington, MA, and many others) and improvements in dispensing equipment, the quality of epoxy bonds is sufficient for many applications. Equipment is available from ADVANCED SEMICONDUCTOR MATERIALS AMERICA, INC., Assembly Products Group in Chandler, AZ (Automatic), and West Bond in Orange, CA (Manual).

Reflow: By preparing the substrate with tin or solder plating, reflow soldering can be suitably performed using a modified wire bonder. The probe is used as a soldering tip. WEST BOND or UNITEK bonders make suitable bonds.

HEWLETT PACKARD

SURFACE MOUNT SOT 23 PIN DIODES FOR RF SWITCHING AND ATTENUATING

HSMP-3800 Series
HSMP-3810 Series
HSMP-3830 Series

Features

SURFACE MOUNT PACKAGE
- **Standard and Low Profile**
- **Dual Versions Available**

DESIGNED FOR RELIABILITY AND QUALITY
- **Gold Metallized Chip**
- **Silicon Nitride Passivated Chip**

LOW SERIES RESISTANCE

LOW CAPACITANCE

LOW HARMONIC DISTORTION

LARGE DYNAMIC RANGE

Description/Applications

These PIN diodes are specifically designed for applications requiring devices in the SOT-23 surface mount package. The HSMP-38XX series in standard or low profile has options for bulk or tape and reel. This series offers a wide range of specifications and package configurations to give the designer wide flexibility.

Typical applications of these PIN diodes are duplexers, switches, phase shifters, pulse and amplitude modulators, limiters, leveling circuits and attenuators.

Maximum Ratings

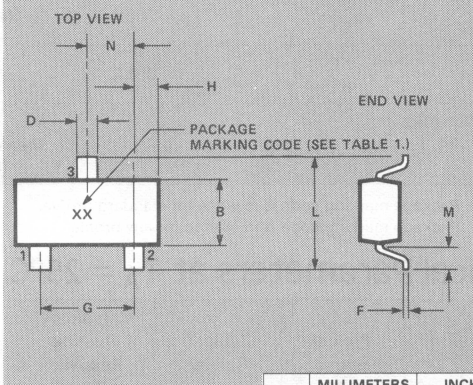
Junction Operating and Storage Temperature Range ..... -65°C to +150°C
DC Power Dissipation
(for each diode at T_{CASE} = 25°C) ..... 250 mW
(Derate linearly to zero at +150°C).
Peak Inverse Voltage (P_{IV}) ..... Same as V_{BR}
Forward Current (I_F) (1 μs pulse) ..... 1 Amp

Operation in excess of any one of these conditions may result in permanent damage to this device.

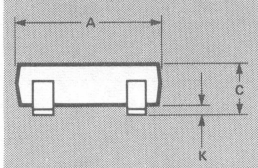
Package Characteristics

Lead Material ..... Alloy 42
Lead Finish ..... Tin-Lead 95-5%
Maximum Soldering Temperature ..... 260°C for 5 sec.
Minimum Lead Strength ..... 2 pounds pull
Typical Package Inductance ..... 2 nH
Typical Package Capacitance ..... 0.08 pF (opposite leads)

STANDARD PROFILE



SIDE VIEW



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.06	0.110	0.120
B	1.20	1.40	0.047	0.055
C*	0.85	1.20	0.033	0.047
D	0.37	0.45	0.015	0.018
F	0.086	0.152	0.003	0.006
G	1.78	2.04	0.070	0.080
H	0.45	0.60	0.018	0.024
K*	0.10	0.25	0.004	0.010
L	2.10	2.50	0.083	0.098
M	0.45	0.60	0.018	0.024
N	0.89	1.04	0.035	0.041

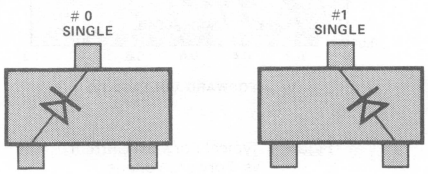
NOTE: MEETS ALL JEDEC DIMENSIONAL REQUIREMENTS FOR TO-236AA/AB*.

*LOW PROFILE option:
with C min/max of 0.89/1.04 millimeters, 0.035/0.041 inches;
with K min/max of 0.013/0.10 millimeters, 0.0005/0.004 inches.

Outline 23

Package Lead Code Identification

TOP VIEW



PIN Diodes

Electrical Specifications at $T_A = 25°C$

TABLE 1.

Part Number HSMP-	Package Marking Code[1]	Lead Code	Nearest Equivalent Axial Lead Part No. 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Series Resistance R_S (Ω)	Maximum Total Capacitance C_T (pF)	Minimum High Resistance R_H (Ω)	Maximum Low Resistance R_L (Ω)
3800 3801	D0 D1	0 1	3080	100	2.5	0.35	1000	8
3810 3811	E0 E1	0 1	3081	100	4.0	0.35	1500	10
3830 3831	K0 K1	0 1	3077	200	1.5	0.3	—	—
Test Conditions				$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$	$I_F = 100$ mA f = 100 MHz	$V_R = 50$ V f = 1 MHz	$I_F = 0.01$ mA f = 100 MHz	$I_F = 20$ mA f = 100 MHz

Note: 1. Package marking code is in white for standard profile.
Package marking code is in orange for low profile.

Typical Parameters at $T_A = 25°C$

Part Number HSMP-	Typical Series Resistance R_S (Ω)	Typical Carrier Lifetime τ (ns)	Typical Reverse Recovery Time T_{rr} (ns)
3800 3801	55	1800	500
3810 3811	75	1500	300
3830 3831	25	500	80
Test Conditions	$I_F = 1$ mA f = 100 MHz	$I_F = 50$ mA $I_R = 250$ mA	$V_R = 10$ V $I_F = 20$ mA 90% Recovery

Typical Parameters at $T_A = 25°C$ (unless othewise noted)

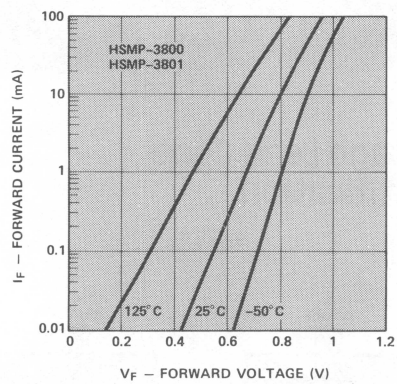


Figure 1. Typical Forward Current vs. Forward Voltage

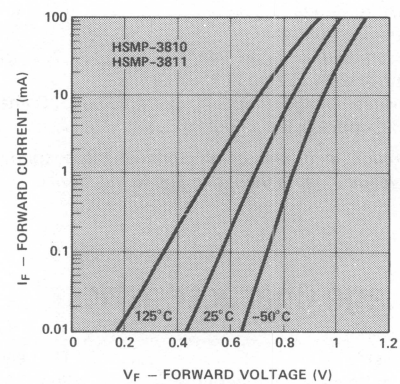


Figure 2. Typical Forward Current vs. Forward Voltage

Typical Parameters (continued)

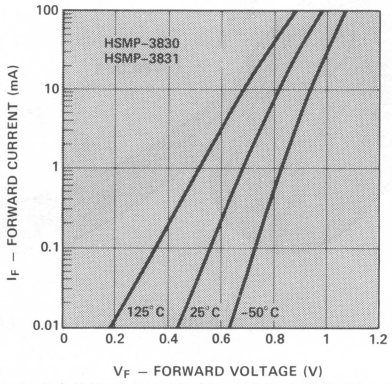


Figure 3. Typical Forward Current vs. Forward Voltage

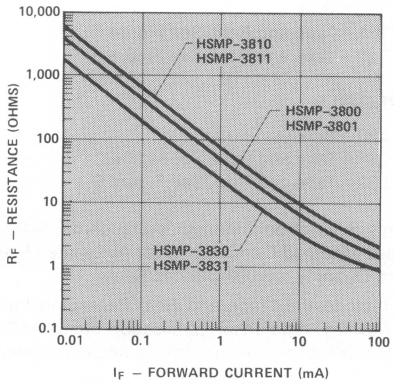


Figure 4. Typical RF Resistance vs. Forward Bias Current

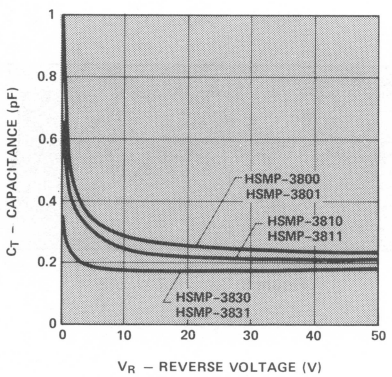


Figure 5. Typical Capacitance vs. Reverse Voltage

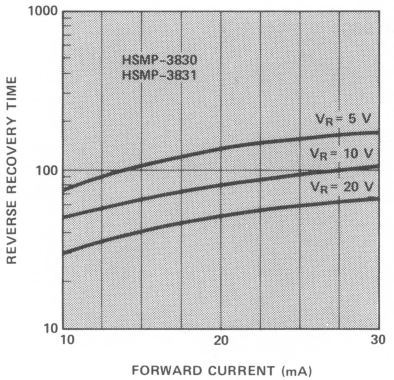


Figure 6. Typical Reverse Recovery Time vs. Reverse Voltage

Ordering Information

STANDARD PROFILE

Option T30 = Bulk
Option T31 = Tape and Reel, See Figure 7
Option T32 = Tape and Reel, See Figure 8

LOW PROFILE

Option L30 = Bulk
Option L31 = Tape and Reel, See Figure 7
Option L32 = Tape and Reel, See Figure 8

Conforms to Electronic Industries Standard RS-481 "Taping of Surface Mounted Components for Automated Placement". Standard Quantity is 3,000 Devices/Reel.

Please refer to the "Tape and Reel Packaging for Surface Mount Devices" data sheet, publication number 5954-2077,* for more detailed information on tape and reel dimensions.

Specify Part Number followed by Option Number
Example:

HSMP-38XX Option X XX

- XX — Bulk or Tape and Reel Option
- X — Profile: Standard = T; or Low = L
- HSMP-38XX — Part Number
- HSMP- — Surface Mount PIN
- HSMP — HP Standard Part

*Catalog page number 4-127.

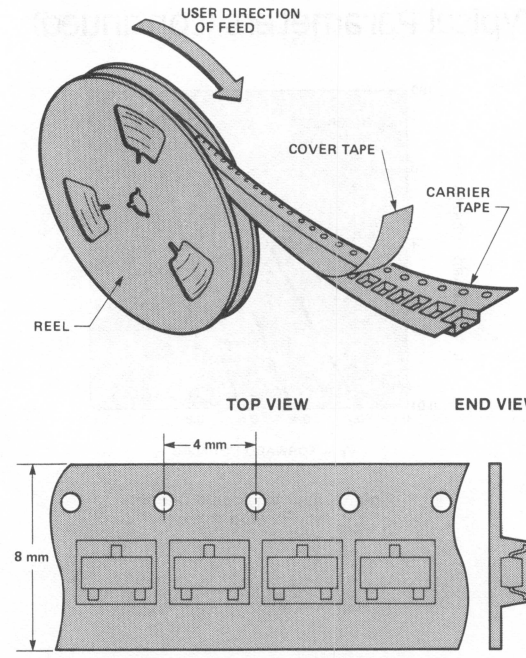


Figure 7. Options T31, L31

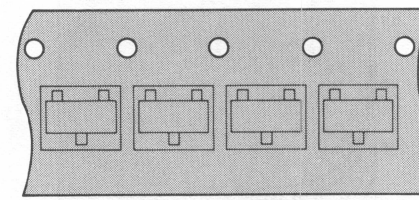


Figure 8. Options T32, L32

HEWLETT PACKARD

PIN DIODES FOR RF SWITCHING AND ATTENUATING

1N5719 5082-3080
1N5767 5082-3081
5082-3001/02 5082-3168/88
5082-3039 5082-3379
5082-3042/43 HPND-4165/66
5082-3077

Features

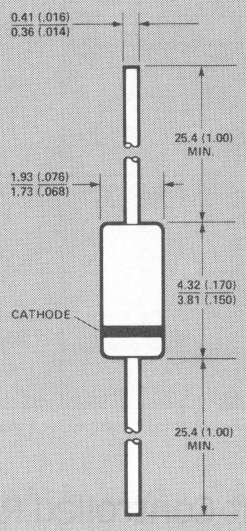
LOW HARMONIC DISTORTION

LARGE DYNAMIC RANGE

LOW SERIES RESISTANCE

LOW CAPACITANCE

LOW TEMPERATURE COEFFICIENT
Typically Less Than 20%
Resistance Change from
25°C to 100°C



DIMENSIONS IN MILLIMETERS AND (INCHES).

Outline 15

Description / Applications

These general purpose switching diodes are intended for low power switching applications such as RF duplexers, antenna switching matrices, digital phase shifters, and time multiplex filters. The 5082-3168/3188 are optimized for VHF/UHF bandswitching.

The RF resistance of a PIN diode is a function of the current flowing in the diode. These current controlled resistors are specified for use in control applications such as variable RF attenuators, automatic gain control circuits, RF modulators, electrically tuned filters, analog phase shifters, and RF limiters.

Maximum Ratings

Junction Operating and Storage Temperature Range ..... -65°C to +150°C

Power Dissipation at 25°C ..... 250 mW
(Derate linearly to zero at 150°C)

Peak Inverse Voltage (PIV) ..... same as V_{BR}

Outline 15 diodes are available on tape and reel. The tape and reel specification is patterned after RS-296-D.

Mechanical Specifications

The HP Outline 15 package has a glass hermetic seal with dumet leads. The lead finish is 95-5 tin-lead (SnPb) for all PIN diode products except the 5082-3042 and -3043, which have gold plated leads. The leads on the Outline 15 package should be restricted so that the bend starts at least 1/16 inch (1.6 mm) from the glass body. With this restriction, Outline 15 package will meet MIL-STD-750, Method 2036, Conditions A (4 lbs., [1.8 kg.], tension for 30 minutes) and E. The maximum soldering temperature is 230°C for five seconds. Typical package inductance and capacitance are 2.5 nH and 0.13 pF, respectively. Marking is by digital coding with a cathode band.

General Purpose Diodes
Electrical Specifications at T_A=25°C

Part Number 5082-	Maximum Total Capacitance C_T (pF)	Minimum Breakdown Voltage V_{BR} (V)	Maximum Residual Series Resistance R_S (Ω)	Effective Carrier Lifetime τ (ns)	Reverse Recovery Time t_{rr} (ns)
GENERAL PURPOSE SWITCHING AND ATTENUATING					
-3002	0.25	300	1.0	100 (min.)	100 (typ.)
-3001	0.25	200	1.0	100 (min.)	100 (typ.)
-3039	0.25	150	1.25	100 (min.)	100 (typ.)
IN5719	0.3**	150	1.25	100 (min.)	100 (typ.)
-3077	0.3	200	1.5	100 (min.)	100 (typ.)
FAST SWITCHING					
-3042	0.4*	70	1.0*	35 (typ.)*	5 (max.)
-3043	0.4*	50	1.5*	35 (typ.)*	10 (max.)
BAND SWITCHING					
-3188	1.0*	35	0.6**	70 (typ.)*	12 (typ.)
-3168	2.0*	35	0.5**	70 (typ.)*	12 (typ.)
Test Conditions	V_R = 50 V *V_R = 20 V **V_R = 100 V f = 1 MHz	V_R = V_{BR} Measure $I_R \leq 10\ \mu A$	I_F = 100 mA *I_F = 20 mA **I_F = 10 mA f = 100 MHz	I_F = 50 mA I_R = 250 mA *I_F = 10 mA *I_R = 6 mA	I_F = 20 mA V_R = 10 V 90% Recovery

Note: Typical CW power switching capability for a shunt switch in a 50Ω system is 2.5W.

RF Current Controlled Resistor Diodes
Electrical Specifications at T_A=25°C

Part Number	Effective Carrier Lifetime τ (ns)	Minimum Breakdown Voltage V_{BR} (V)	Maximum Residual Series Resistance R_S (Ω)	Maximum Total Capacitance C_T (pF)	High Resistance Limit, R_H (Ω)		Low Resistance Limit, R_L (Ω)		Maximum Difference in Resistance vs. Bias Slope, $\Delta\chi$
					Min.	Max.	Min.	Max.	
HPND-4165	100	100	1.5	0.3	1100	1660	16	24	.04
HPND-4166	100	100	1.5	0.3	830	1250	12	18	.04
5082-3080	2000 (typ.)	100	2.5	0.4	1000			8**	
IN5767*	1300 (typ.)	100	2.5	0.4	1000			8**	
5082-3379	2000 (typ.)	50		0.4				8**	—
5082-3081	2500 (typ.)	100	3.5	0.4	1500			8**	
Test Conditions	I_F = 50 mA I_R = 250 mA	V_R = V_{BR}, Measure $I_R \leq 10\ \mu A$	I_F = 100 mA f = 100 MHz	V_R = 50 V f = 1 MHz	I_F = 0.01 mA f = 100 MHz		I_F = 1.0 mA **I_F = 20 mA f = 100 MHz		Batch Matched at I_F = 0.01 mA and 1.0 mA f = 100 MHz

*The 1N5767 has the additional specifications: τ = 1.0 μsec minimum
I_R = 1 μA maximum at V_R = 50V
V_F = 1V maximum at I_F = 100mA.

Typical Parameters at $T_A = 25°C$ (unless otherwise noted)

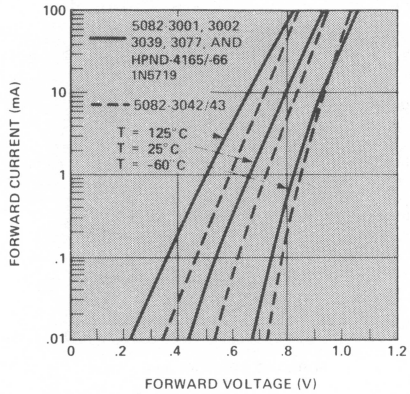


Figure 1. Typical Forward Current vs. Forward Voltage.

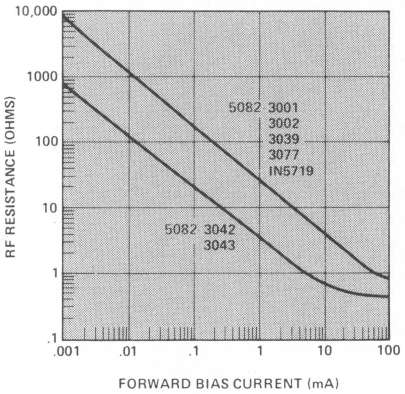


Figure 2. Typical RF Resistance vs. Forward Bias Current.

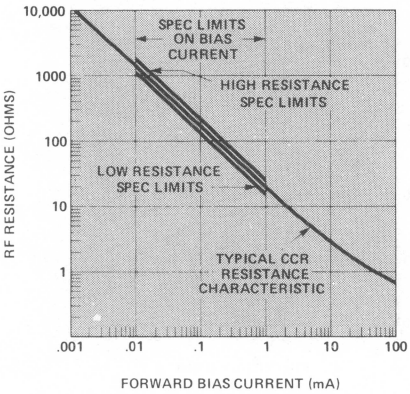


Figure 3. Typical RF Resistance vs. Bias for HPND-4165.

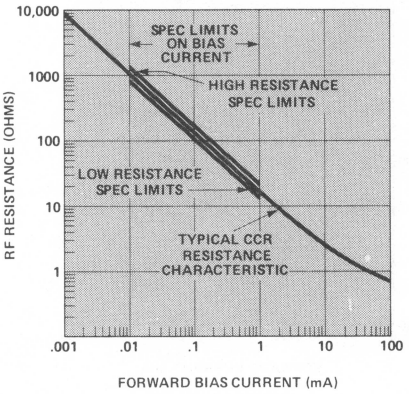


Figure 4. Typical RF Resistance vs. Bias for HPND-4166.

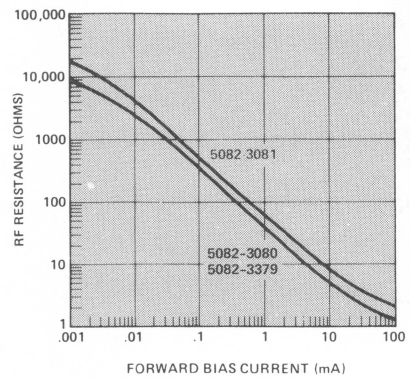


Figure 5. Typical RF Resistance vs. Forward Bias Current.

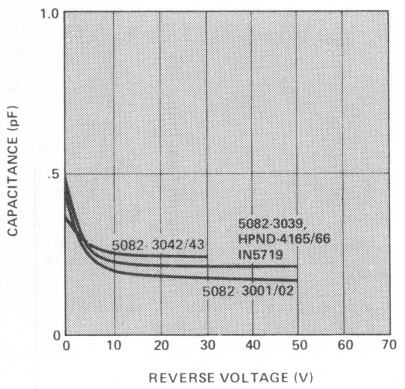


Figure 6. Typical Capacitance vs. Reverse Voltage.

Typical Parameters (Continued)

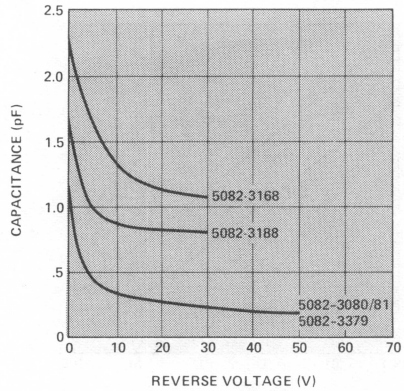


Figure 7. Typical Capacitance vs. Reverse Voltage.

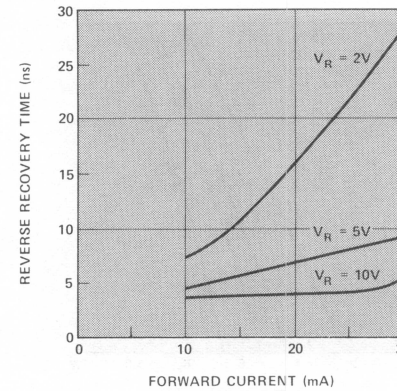


Figure 8. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3042, 3043.

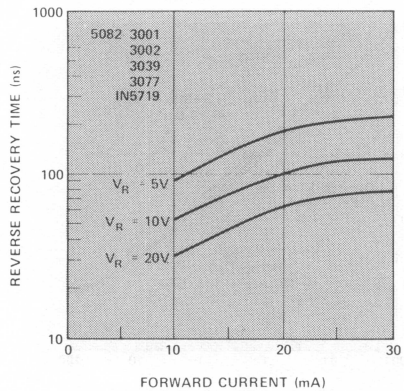


Figure 9. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages.

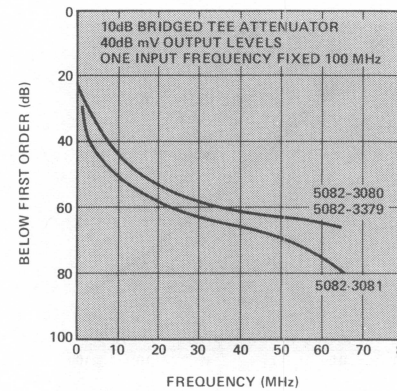


Figure 10. Typical Second Order Intermodulation Distortion.

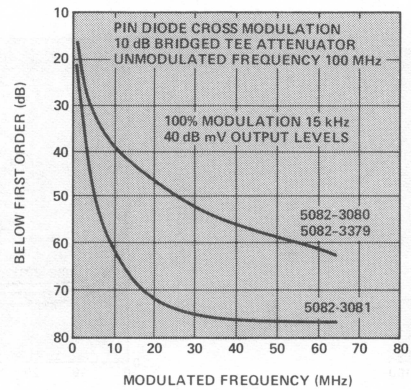


Figure 11. Typical Cross Modulation Distortion.

HEWLETT PACKARD

PIN DIODE LIMITER

5082-3071

Features

HIGH POWER HANDLING CAPABILITY
50 W Peak Pulse Power

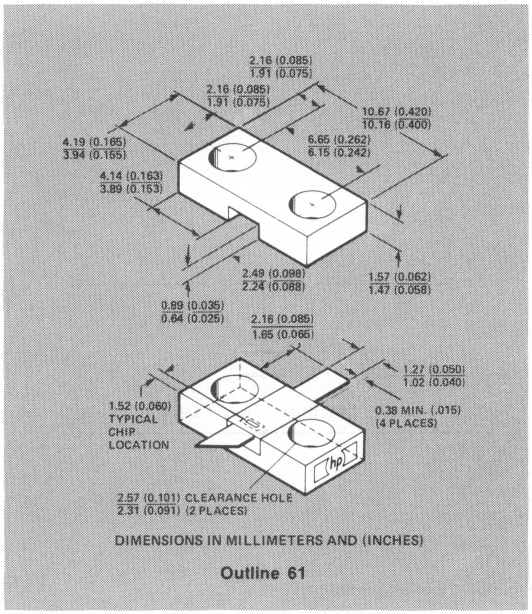
LOW INTERMODULATION PRODUCTS
Typical 0.2 W Threshold Assures Wide Dynamic Linear Range

BROAD BANDWIDTH
500 MHz to 10 GHz

LOW INSERTION LOSS
Less than 1 dB in X-band

EASY TO USE
Package Compatible with Stripline and Microstrip

NEGLIGIBLE SPIKE LEAKAGE



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 61

Description/Applications

The HP 5082-3071 passive limiter chip is functionally integrated into a 50 ohm transmission line to provide a broadband, linear, low insertion loss transfer characteristic for small signal levels. At higher signal levels self-rectification reduces the diode resistance to provide limiting as shown in Figure 2. Limiter performance is practically independent of temperature over the rated temperature range.

The 5082-3071 limiter module is designed for applications in telecommunication equipment, ECM receivers, distance measuring equipment, radar receivers, telemetry equipment, and transponders operating anywhere in the frequency range from 500 MHz through 10 GHz. An external dc return is required for self bias operation. This dc return is often present in the existing circuit, i.e. inductively coupled antennas, or it can be provided by a $\lambda/4$ resonant shunt transmission line. Selection of a high characteristic impedance for the shunt transmission line affords broadband operation. Another easy to realize dc return consists of a small diameter wire connected at a right angle to the electric field in a microstrip or stripline circuit. A 10 mA forward current will actuate the PIN diode as a shunt switch providing approximately 20 dB of isolation.

Maximum Ratings

Junction Operating and Storage Temperature Range	-65° C to +125° C
Power Dissipation[1]	1.0 W
Peak Incident Pulse Power[2]	50 W
Peak Inverse Voltage	50 V
Soldering Temperature	230° C for 5 sec

Notes:
1. Device properly mounted in sufficient heak sink at $T_A = 25°C$, derate linearly to zero at maximum operating temperature.
2. $t_p = 1\ \mu s$, f = 10 GHz, Du = 0.001, $Z_0 = 50\ \Omega$, $T_A = 25°C$.

Mechanical Specifications

The cover channel supplied with each diode should be used in balanced stripline circuits in order to provide good electrical continuity from the upper to the lower ground plane through the package base metal. Higher order modes will be excited if this cover is left off or if poor electrical contact is made to the ground plane.

The package transmission channel is filled with epoxy resin which combines a low expansion coefficient with high chemical stability. Outline 61 has a gold plated copper body with gold plated Kovar leads.

Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Package Outline	Heat Sink	Maximum Insertion Loss (dB)	Maximum SWR	Maximum RF Leakage Power (W)	Typical Recovery Time (ns)
3071	61	Cathode	1.2	2.0	1.0	100
Test Conditions	—	—	P_{in} = 0 dBm f = 9.4GHz	P_{in} = 0 dBm f = 9.4GHz	P_{in} = 50 W 1 μsec	P_{in} = 50 W 1 μsec

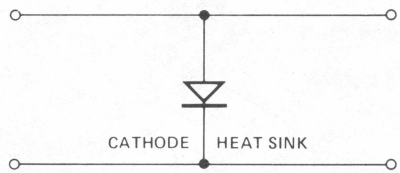


Figure 1. Heat Sink Polarity

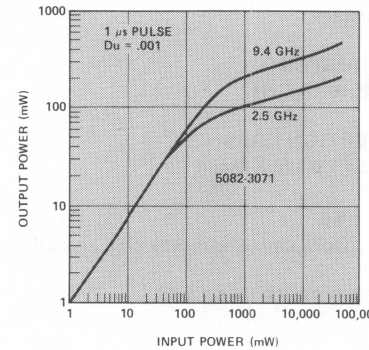


Figure 2. Typical Pulse Limiting Characteristics

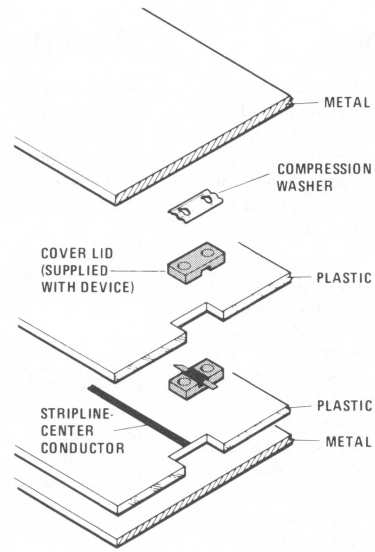


Figure 3. Suggested Stripline Assembly

HEWLETT PACKARD

STRIPLINE PIN DIODE SWITCHES/ ATTENUATORS

5082-3040
5082-3041
5082-3340

Features

LOW COST TO USE
Designed for Easy Mounting

BROADBAND OPERATION
HF through X-band

LOW INSERTION LOSS
Less than 0.5 dB to 10 GHz (5082-3040, -3340)

HIGH ISOLATION
Greater than 20 dB to 10 GHz

FAST SWITCHING/MODULATING
5 ns Typical (5082-3041)

LOW DRIVE CURRENT REQUIRED
Less than 20 mA for 20 dB Isolation (5082-3041)

Description/Applications

These diodes are designed for applications in microwave and HF-UHF systems using stripline or microstrip transmission line techniques.

Typical circuit functions performed consist of switching, duplexing, multiplexing, leveling, modulating, limiting, or gain control functions as required in TR switches, pulse modulators, phase shifters, and amplitude modulators operating in the frequency range from HF through Ku-Band.

These diodes provide nearly ideal transmission characteristics from HF through Ku-Band.

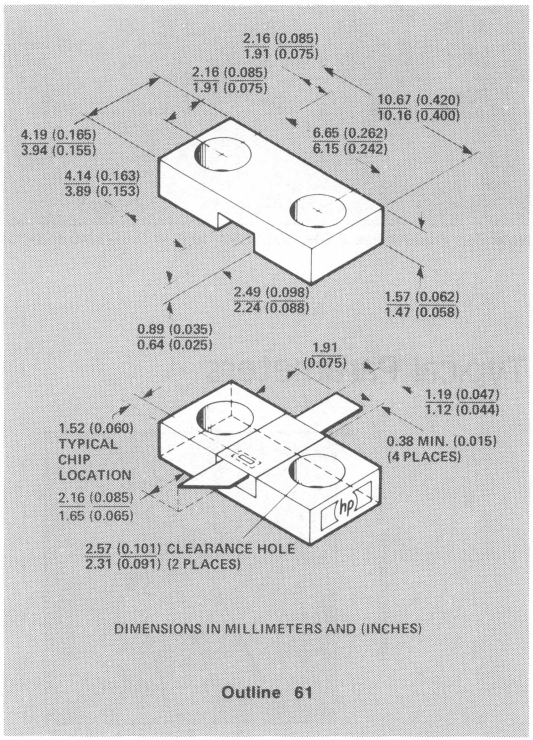
The 5082-3340 is a reverse polarity device with characteristics similar to the 5082-3040. The 5082-3041 is recommended for applications requiring fast switching or high frequency modulation of microwave signals, or where the lowest bias current for the maximum attenuation is required.

More information is available in HP AN 922 (Applications of PIN Diodes) and 929 (Fast Switching PIN Diodes).

Mechanical Specifications

The cover channel supplied with each diode should be used in balanced stripline circuits in order to provide good electrical continuity from the upper to the lower ground plane through the package base metal. Higher order modes will be excited if this cover is left off or if poor electrical contact is made to the ground plane.

The package transmission channel is filled with epoxy resin which combines a low expansion coefficient with high chemical stability. Outline 61 has a gold plated copper body with gold plated Kovar leads.



Outline 61

Maximum Ratings

Part No. 5082-	-3040 -3340	-3041
Junction Operating and Storage Temperature Range	-65° C to 125° C	-65° C to 125°
Power Dissipation[1]	2.5 W	1.0 W
Peak Incident Pulse Power[2]	225 W	50 W
Peak Inverse Voltage	150 V	70 V
Soldering Temperature	230° C for 5 sec.	

Notes:
1. Device properly mounted in sufficient heat sink at 25°C, derate linearly to zero at maximum operating temperature.
2. t_p = 1 μs, f = 10 GHz, Du = 0.001, Z_O = 50 Ω, T_A = 25° C.

PIN Diodes

Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Package Outline	Heat Sink	Minimum Isolation (dB)	Maximum Insertion Loss (dB)	Maximum SWR	Maximum Reverse Recovery Time t_{rr} (ns)	Typical Carrier Lifetime τ (ns)	Typical CW Power Switching Capability P_A (W)
3040	61	Anode	20	0.5	1.5	—	400	30
3041	61	Cathode	20	1.0	1.5	10	35*	13
3340	61	Cathode	20	0.5	1.5	—	400	30
Test Conditions (Note 3)	—	—	I_F=100mA (Except 3041; I_F=20mA)	I_F = 0 P_{in} = 1mW	I_F = 0 P_{in} = 1mW	I_F = 20mA V_R = 10V Recovery to 90%	I_F = 50mA I_R = 250mA *I_F = 10mA *I_R = 6mA	—

Note: Test Frequencies: 8 GHz 5082-3041; 10 GHz 5082-3040,and -3340.

Typical Parameters

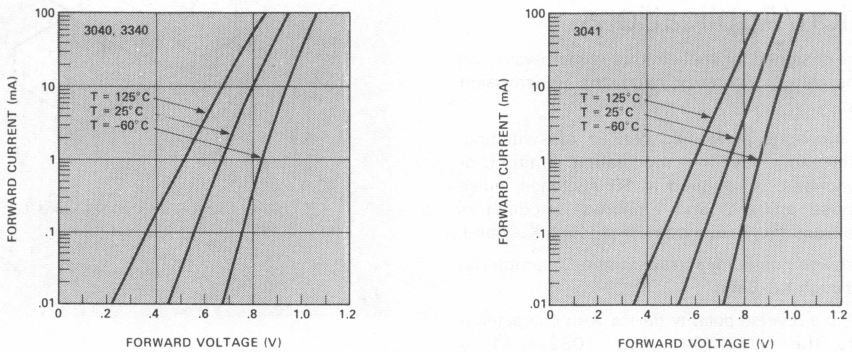


Figure 1. Typical Forward Characteristics.

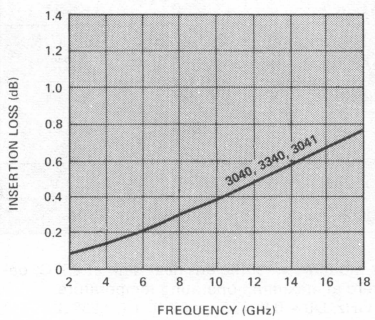


Figure 2. Typical Insertion Loss vs. Frequency.

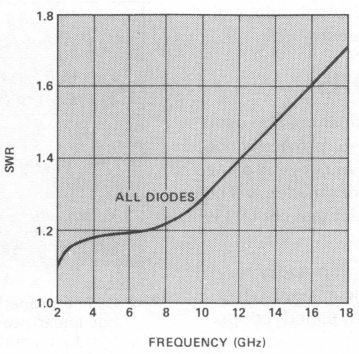


Figure 3. Typical SWR vs. Frequency.

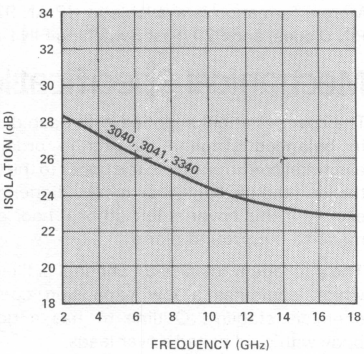


Figure 4. Typical Isolation vs. Frequency.

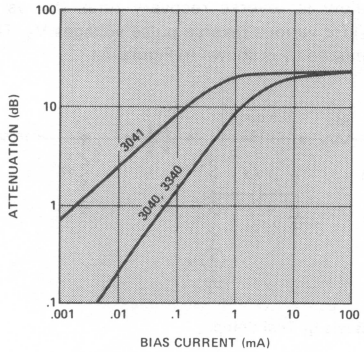
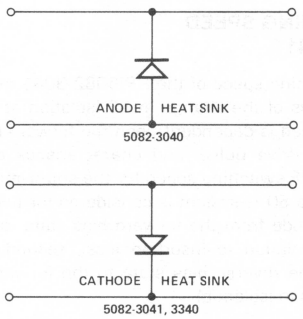


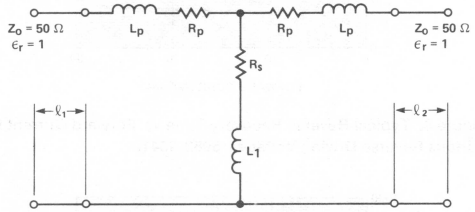
Figure 5. Typical Attenuation Above Zero Bias Insertion Loss vs. Bias Current at f = 8 GHz.



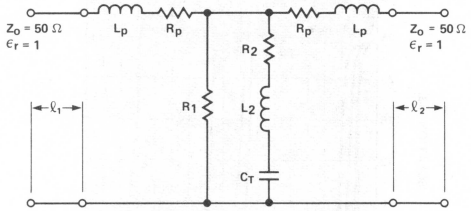
HEAT SINK POLARITY

Equivalent Circuits

Forward Bias (Isolation State)



Zero Bias (Insertion Loss State)



Typical Equivalent Circuit Parameters - Forward Bias

Part Number 5082-	Lp (pH)	Rp (Ω)	Rs (Ω)	L_1 (pH)	ℓ_1 (mm)	ℓ_2 (mm)
3040, 3340	200	0.25	1.0	20	2.4	5.0
3041	220	0.25	1.0	20	2.4	5.0

Typical Equivalent Circuit Parameters - Zero Bias

Part Number 5082-	Lp (pH)	Rp (Ω)	R_1 (KΩ)	L_2 (pH)	R_2 (KΩ)	C_T (pF)	ℓ_1 (mm)	ℓ_2 (mm)
3040, 3340	200	0.25	∞	0	5.0	0.10	2.4	5.0
3041	220	0.25	∞	0	1.5	0.15	2.4	5.0

Typical Switching Parameters

RF SWITCHING SPEED HP 5082-3041

The RF switching speed of the HP 5082-3041 may be considered in terms of the change in RF isolation at 2 GHz. This switching speed is dependent upon the forward bias current, reverse bias drive pulse, and characteristics of the pulse source. The RF switching speed for the shunt-mounted stripline diode in a 50 Ω system is considered for two cases: one driving the diode from the forward bias state to the reverse bias state (isolation to insertion loss), second, driving the diode from the reverse bias state to the forward bias state (insertion loss to isolation).

The total time it takes to switch the shunt diode from the isolation state (forward bias) to the insertion loss state (reverse bias) is shown in Figure 6. These curves are for three forward bias conditions with the diode driven in each case with three different reverse voltage pulses (V_{PR}). The total switching time for each case includes the delay time (pulse initiation to 20 dB isolation) and transition time (20 dB isolation to 0.9 dB isolation). Slightly faster switching times may be realized by spiking the leading edge of the pulse or using a lower impedance pulse driver.

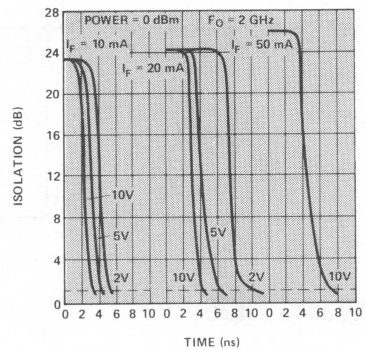


Figure 6. Isolation vs. Time (Turn-on) for HP 5082-3041. Frequency, 2 GHz.

The time it takes to switch the diode from zero or reverse bias to a given isolation is less than the time from isolation to the insertion loss case. For all cases of forward bias generated by the pulse generator (positive pulse), the RF switching time from the insertion loss state to the isolation state was less than 2 nanoseconds. A more detailed treatise on switching speed is published in AN929; Fast Switching PIN Diodes.

REVERSE RECOVERY TIME

Shown below is reverse recovery time, (t_{rr}) vs. forward current, (I_F) for various reverse pulse voltages V_R. The circuit used to measure t_{rr} is shown in Figure 7.

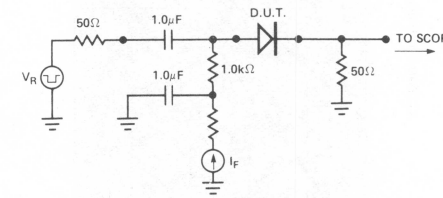


Figure 7. Basic t_{rr} Test Setup.

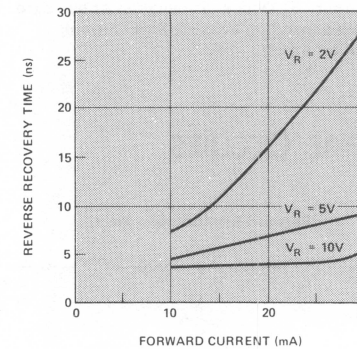


Figure 8. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3041.

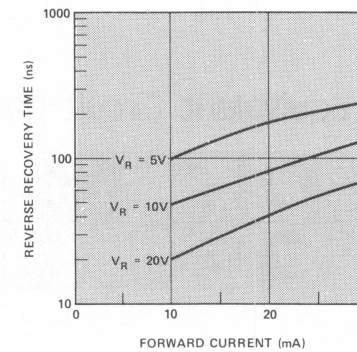


Figure 9. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3340.

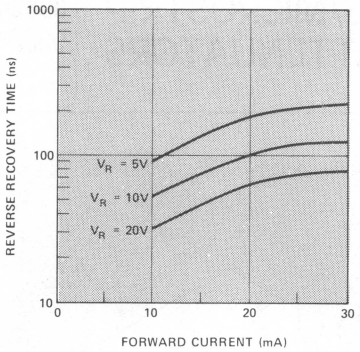


Figure 10. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3040.

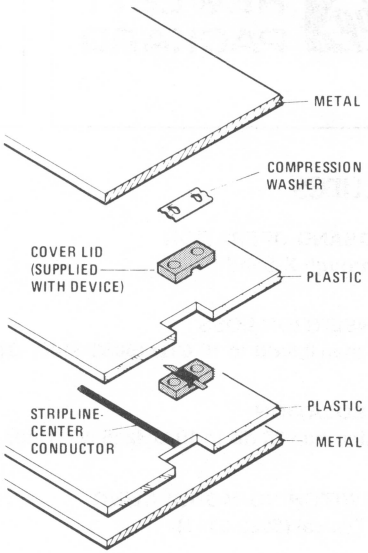


Figure 11. Suggested Stripline Assembly.

HEWLETT PACKARD

HERMETIC PIN DIODES FOR STRIPLINE/MICROSTRIP SWITCHES/ATTENUATORS

5082-3140
5082-3141
5082-3170

Features

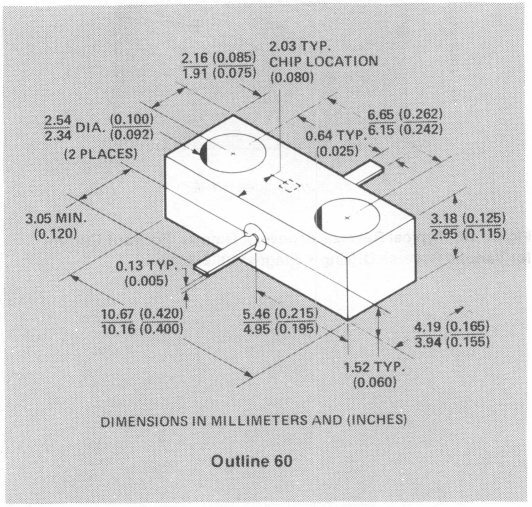
BROADBAND OPERATION
HF through X-band

LOW INSERTION LOSS
Less than 0.5 dB to 10 GHz (5082-3140, -3170)

HIGH ISOLATION
Greater than 20 dB to 10 GHz (5082-3140, -3170)

FAST SWITCHING/MODULATING
5 ns Typical (5082-3141)

LOW DRIVE CURRENT REQUIRED
Less than 20 mA for 20 dB Isolation (5082-3141)



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 60

Description/Applications

The HP 5082-3140 and -3170 are passivated planar devices and the 5082-3141 is a passivated mesa device. All are in a shunt configuration in hermetic stripline packages which are suitable for Hi-Rel applications. These diodes are optimized for good continuity of characteristic impedance which allows a continuous transition when used in 50 ohm microstrip or stripline circuits.

These diodes are designed for applications in microwave and HF-UHF systems using stripline or microstrip transmission line techniques.

Typical circuit functions performed consist of switching, duplexing, multiplexing, leveling, modulating, limiting, or gain control functions as required in TR switches, pulse modulators, phase shifters, and amplitude modulators operating in the frequency range from HF through Ku-Band. These diodes provide nearly ideal transmission characteristics from HF through Ku-Band.

The 5082-3170 is a reverse polarity device with characteristics similar to the 5082-3140.

The 5082-3141 is recommended for applications requiring fast switching or high frequency modulation of microwave signals, or where the lowest bias current for maximum attenuation is required.

More information is available in HP Application Note 922 (Applications of PIN Diodes) and 929 (Fast Switching PIN Diodes).

Maximum Ratings

Part No. 5082-	-3140 -3170	-3141
Junction Operating and Storage Temperature Range	−65° C to 150° C	−65° C to 150° C
Power Dissipation[1]	1.75 W	0.75 W
Peak Incident Pulse Power[2]	225 W	50 W
Peak Inverse Voltage	150 V	70 V
Soldering Temperature	230° C for 5 sec.	

Notes:
1. Device properly mounted in sufficient heat sink at 25° C, derate linearly to zero at maximum operating temperature.
2. $t_p = 1\ \mu s$, f = 10 GHz, Du = 0.001, $Z_o = 50\ \Omega$, $T_A = 25°\ C$.

Mechanical Specifications

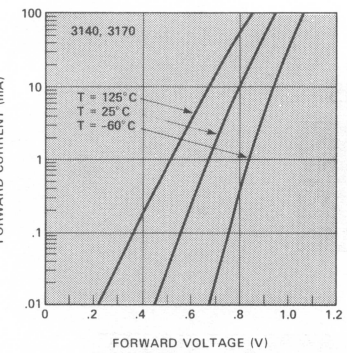
Package Outline 60 is hermetically sealed and capable of meeting the stringent requirements of space level high reliability testing. Both the package and lead materials are gold plated Kovar.

Electrical Specifications at T_A=25°C

Part Number 5082-	Package Outline	Heat Sink	Minimum Isolation (dB)	Maximum Insertion Loss (dB)	Maximum SWR	Maximum Reverse Recovery Time t_{rr} (ns)	Typical Carrier Lifetime τ (ns)	Typical CW Power Switching Capability P_A (W)
3140	60	Anode	20	0.5	1.5	–	400	30
3141	60	Cathode	20	1.0	1.5	10	35	13
3170	60	Cathode	20	0.5	1.5	–	400	30
Test Conditions (Note 3)	–	–	I_F=100mA (Except 3141; I_F=20mA)	I_F = 0 P_{in} = 1mW	I_F = 0 P_{in} = 1mW	I_F = 20mA V_R = 10V Recovery to 90%	I_F = 50mA I_R = 250mA *I_F = 10mA *I_R = 6mA	–

Note 3: Test Frequencies: 8 GHz 5082-3141. 10 GHz 5082-3140, -3170.

Typical Parameters



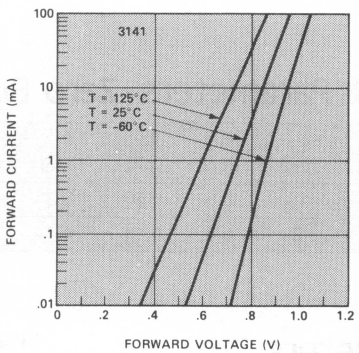


Figure 1. Typical Forward Characteristics.

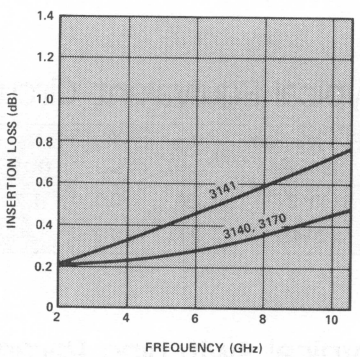


Figure 2. Typical Insertion Loss vs. Frequency.

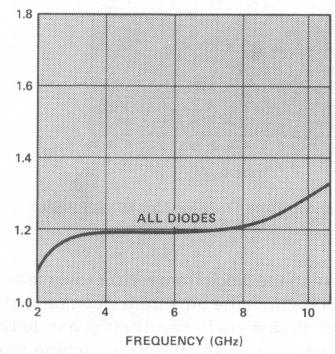


Figure 3. Typical SWR vs. Frequency.

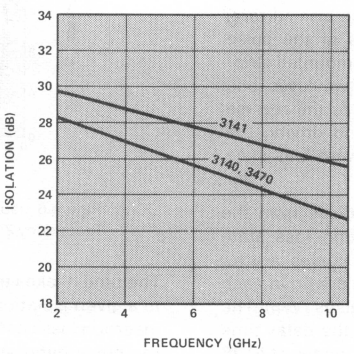


Figure 4. Typical Isolation vs. Frequency.

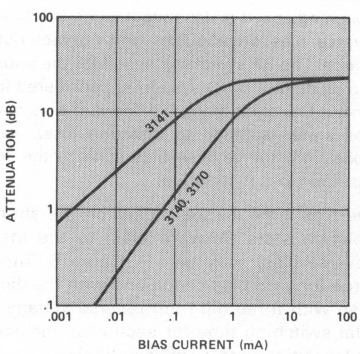
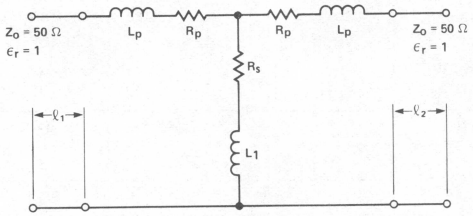


Figure 5. Typical Attenuation Above Zero Bias Insertion Loss vs. Bias Current at f = 8 GHz.

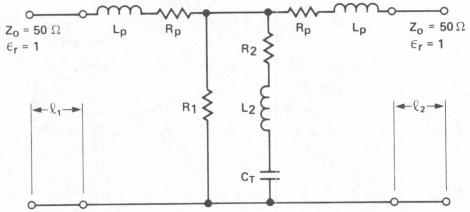
PIN Diodes

Equivalent Circuits

Forward Bias (Isolation State)



Zero Bias (Insertion Loss State)



Typical Equivalent Circuit Parameters - Forward Bias

Part Number 5082-	Lp (pH)	Rp (Ω)	Rs (Ω)	L_1 (pH)	ℓ_1 (mm)	ℓ_2 (mm)
3140, 3170	150	0.0	0.95	30	3.8	3.8
3141	150	0.0	0.8	20	3.8	3.8

Typical Equivalent Circuit Parameters - Zero Bias

Part Number 5082-	Lp (pH)	Rp (Ω)	R_1 (KΩ)	L_2 (pH)	R_2 (KΩ)	C_T (pF)	ℓ_1 (mm)	ℓ_2 (mm)
3140, 3170	30	0.0	1.2	16	0.0	0.20	5.3	5.3
3141	200	0.0	∞	0	0.4	0.14	4.4	4.4

Typical Switching Parameters

RF SWITCHING SPEED

HP 5082-3141

The RF switching speed of the HP 5082-3141 may be considered in terms of the change in RF isolation at 2 GHz. This switching speed is dependent upon the forward bias current, reverse bias drive pulse, and characteristics of the pulse source. The RF switching speed for the shunt-mounted stripline diode in a 50 Ω system is considered for two cases, one driving the diode from the forward bias state to the reverse bias state (isolation to insertion loss), second driving the diode from the reverse bias state to the forward bias state (insertion loss to isolation).

The total time it takes to switch the shunt diode from the isolation state (forward bias) to the insertion loss state (reverse bias) is shown in Figure 6. These curves are for three forward bias conditions with the diode driven in each case with three different reverse voltage pulses (V_{PR}). The total switching time for each case includes the delay time (pulse initiation to 20 dB isolation) and transition time (20 dB isolation to 0.9 dB isolation). Slightly faster switching times may be realized by spiking the leading edge of the pulse or using a lower impedance pulse driver.

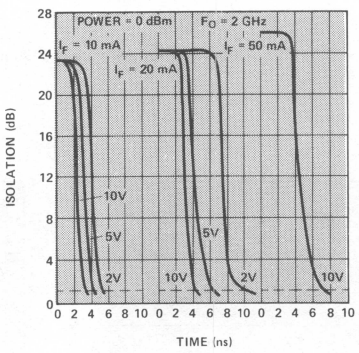


Figure 6. Isolation vs. Time (Turn-on) for HP 5082-3141 Frequency,2 GHz.

The time it takes to switch the diode from zero or reverse bia to a given isolation is less than the time from isolation to th insertion loss case. For all cases of forward bias generated b the pulse generator (positive pulse), the RF switching tim from the insertion loss state to the isolation state was les than 2 nanoseconds. A more detailed treatise on switchin speed is published in AN929; Fast Switching PIN Diodes.

REVERSE RECOVERY TIME

Shown below is reverse recovery time, (t_{rr}) vs. forward current, (I_F) for various reverse pulse voltages V_R. The circuit used to measure t_{rr} is shown in Figure 7.

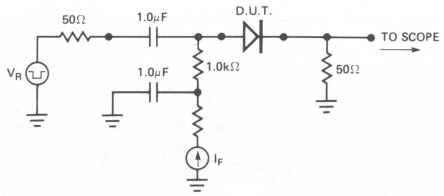


Figure 7. Basic t_{rr} Test Setup.

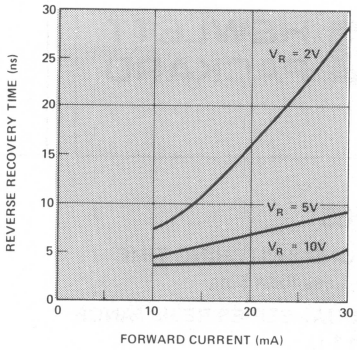


Figure 8. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3141.

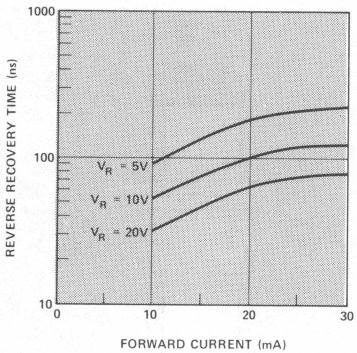


Figure 9. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3140.

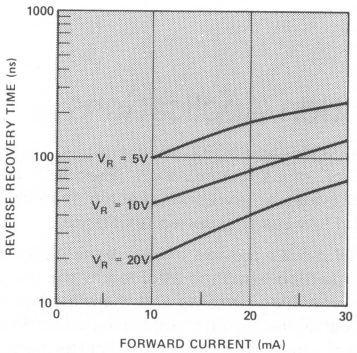


Figure 10. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3170.

HEWLETT PACKARD

PIN DIODES FOR FAST SWITCHING AND ATTENUATING

5082-3305
5082-3306

Features

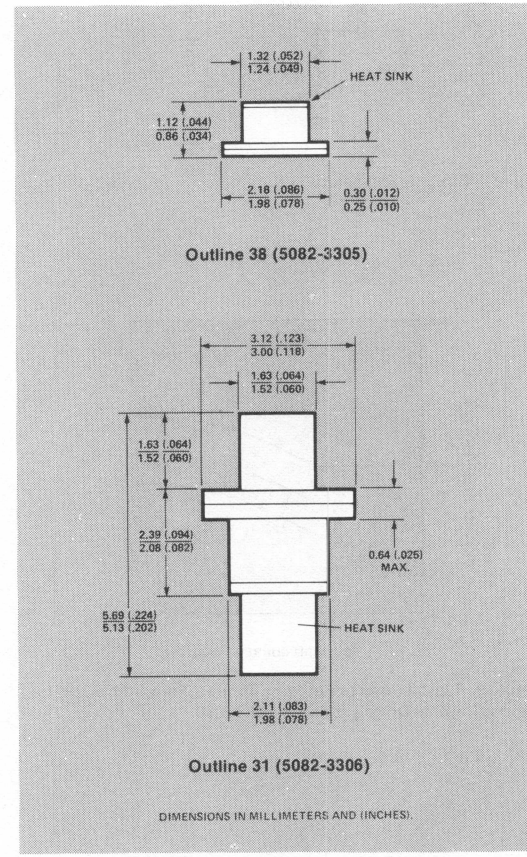
NANOSECOND SWITCHING TIME
Typically Less than 5 ns

LOW RESIDUAL SERIES RESISTANCE
Less than 1 Ω

LOW DRIVE CURRENT REQUIRED
Less than 20 mA for 1 Ω R_S

HIGH POWER LIMITING CAPABILITY
50 W Peak Pulse Power

CATHODE HEAT SINK



Description/Applications

The HP 5082-3305 and 5082-3306 are passivated silicon PIN diodes of mesa construction. Precisely controlled processing provides an exceptional combination of fast RF switching and low residual series resistance.

These HP PIN diodes provide unique benefits in the high isolation to insertion loss ratio afforded by the low residual resistance at low bias currents and the ultra-fast recovery realized through lower stored charge. Where low drive power is desired these diodes provide excellent performance at very low bias currents.

The HP 5082-3305 and 5082-3306 ceramic package PIN diodes are intended for controlling and processing microwave signals up to Ku band. Typical applications include single and multi-throw switches, pulse modulators, amplitude modulators, phase shifters, duplexers, diplexers and TR switches.

Maximum Ratings

Junction Operating and Storage Temperature Range
..... -65°C to +150°C

DC Power Dissipation at T_{CASE} = 25° C
(Derate linearly to zero at 150°C)

HP 5082-3305 ..... 0.7 W
HP 5082-3306 ..... 1.25W

Mechanical Specifications

The HP Package Outline 31 has a metal ceramic hermetic seal. The heat sink stud is gold-plated copper. The opposite stud is gold-plated kovar. Typical package inductance is 1.0 nH and typical package capacitance is 0.2 pF.

The HP Package Outline 38 also has a metal ceramic hermetic seal. The heat sink contact is gold plated copper. The opposite contact is gold-plated kovar. Typical package inductance is 0.4 nH and typical package capacitance is 0.2 pF.

The maximum soldering temperature for diodes in either package is 230°C for 5 seconds.

FAST SWITCHING/ATTENUATING
Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Package Outline	Heat Sink	Minimum Breakdown Voltage V_{BR} (V)	Maximum Total Capacitance C_T (pF)	Maximum Series Resistance R_S (Ω)	Maximum Reverse Recovery Time t_{rr} (ns)
3305	38	Cathode	70	0.4	1.0	10.0
3306	31		70	0.45	1.0	10.0
Test Conditions			$V_R = V_{BR}$, meas. $I_R \leq 10\ \mu A$	f = 1 MHz V_R = 20V	f = 100 MHz I_F = 20mA	I_F = 20mA V_R = 10V 90% Recovery

Typical Parameters

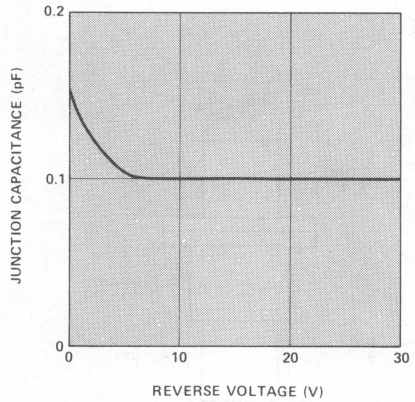


Figure 1. Typical Junction Capacitance vs. Reverse Voltage.

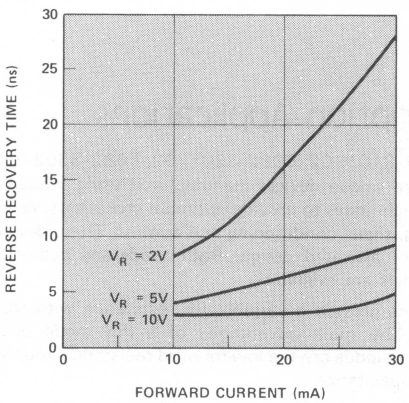


Figure 2. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages.

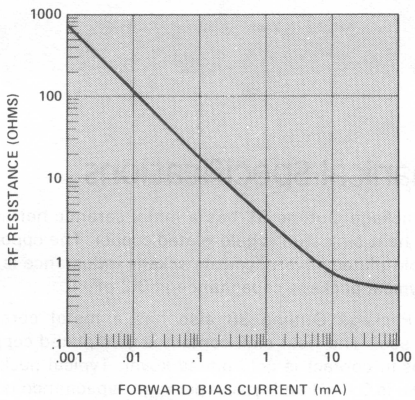


Figure 3. Typical RF Resistance vs. Forward Bias Current.

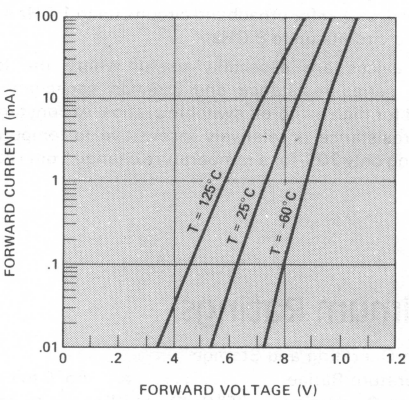


Figure 4. Typical Forward Current vs. Forward Voltage.

HEWLETT PACKARD

PIN DIODES FOR RF POWER SWITCHING/ ATTENUATION

5082-3101
5082-3102
5082-3201
5082-3202
5082-3303
5082-3304

Features

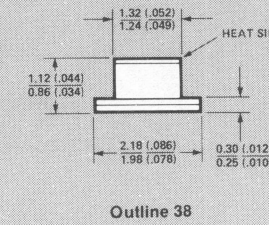
HIGH ISOLATION
Greater Than 25 dB

LOW INSERTION LOSS

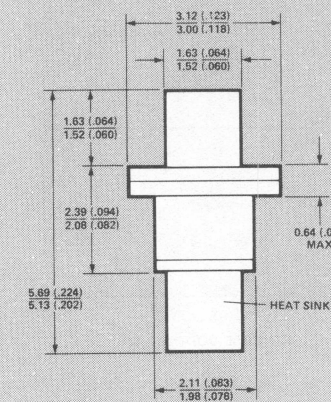
HIGH CONTROL SIGNAL DYNAMIC RANGE
10,000: 1 RF Resistance Change

LOW HARMONIC DISTORTION LIFETIME
Greater Than 100 ns

BOTH ANODE AND CATHODE HEAT SINK MODELS AVAILABLE



Outline 38



Outline 31

DIMENSIONS IN MILLIMETERS AND (INCHES)

Description/Applications

HP 5082-3101/02, 5082-3201/02, 5082-3303/04 PIN diodes are silicon devices manufactured using modern processing techniques to provide optimum characteristics for RF switching, signal conditioning and control. These devices are of planar passivated design. Both anode and cathode heat sink models are available.

PIN diodes provide a variable RF resistance with DC bias current. The main advantages of a PIN diode over PN switching diodes are the low forward resistance and the low device capacitance.

These HP PIN Diodes are intended for use in RF switching, multiplexing, modulating, phase shifting, and attenuating applications from approximately 10 MHz to frequencies well into the microwave region. Due to their low parasitic capacitance and inductance, both HP Package Outline 31 and 38 are well suited for broadband circuits up to 1 GHz and for resonated circuits up to 8 GHz.

These devices are especially useful where the lowest residual series resistance and junction capacitance are required for high on-to-off switching ratios. At constant bias the RF resistance is relatively insensitive to temperature, increasing only 20% for a temperature change from +25°C to +100°C.

Maximum Ratings

Junction Operating and Storage Temperature Range ..... -65°C to +150°C

DC Power Dissipation at 25°C. (Derate linearly to zero at 150°C)

HP 5082-3101, 3102 ..... 1.0 W

HP 5082-3201, 3202, 3303, 3304 ..... 3.0 W

Mechanical Specifications

The HP Package Outline 31 has a metal ceramic hermetic seal. The heat sink stud is gold-plated copper. The opposite stud is gold-plated kovar. Typical package inductance is 1.0 nH and typical package capacitance is 0.2 pF.

The HP Package Outline 38 also has a metal ceramic hermetic seal. The heat sink contact is gold plated copper. The opposite contact is gold-plated kovar. Typical package inductance is 0.4 nH and typical package capacitance is 0.2 pF.

The maximum soldering temperature for diodes in either package is 230°C for 5 seconds.

RF POWER SWITCHING/ATTENUATING

Electrical Specifications at $T_A = 25°C$

Part Number 5082-	Package Outline	Heat Sink	Minimum Breakdown Voltage V_{BR} (V)	Maximum Total Capacitance C_T (pF)	Maximum Residual Series Resistance R_S (Ω)	Minimum Carrier Lifetime τ (ns)	Typical Reverse Recovery Time t_{rr} (ns)	Typical CW Power Handling Capability P_A (W)
3101	38	Anode	200	0.32	1.2	100	100	40
3102	38		300	0.30	0.8	100	100	60
3201	31		200	0.35	1.2	100	100	120
3202	31		300	0.32	0.8	100	100	180
3303	31	Cathode	200	0.40	1.2	100	100	120
3304	31		300	0.32	0.8	100	100	180
Test Conditions			$V_R = V_{BR}$, meas. $I_R \leq 10\mu A$	$V_R = 50V$, f = 1MHz	$I_F = 100mA$ f = 100MHz	I_F = 50mA I_R = 250mA	$I_F = 20mA$, $V_R = 10V$ 90% Recovery	Series* Switch in 50Ω System

*Divide by four for a shunt switch.

Typical Parameters

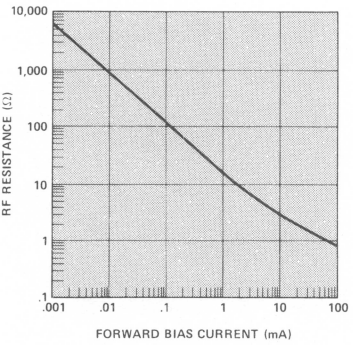


Figure 1. Typical RF Resistance vs. Forward Bias Current

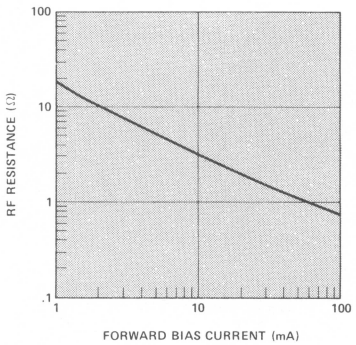


Figure 2. Typical RF Resistance vs. Forward Bias Current.

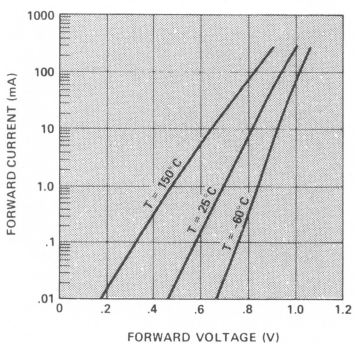


Figure 3. Typical Forward Characteristics.

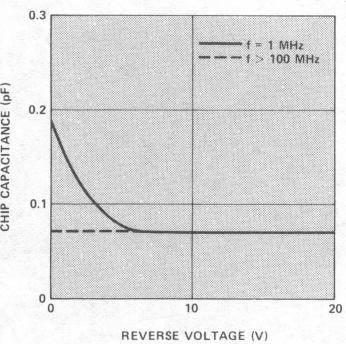
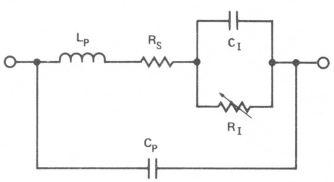


Figure 4. Typical Chip Capacitance vs. Reverse Voltage

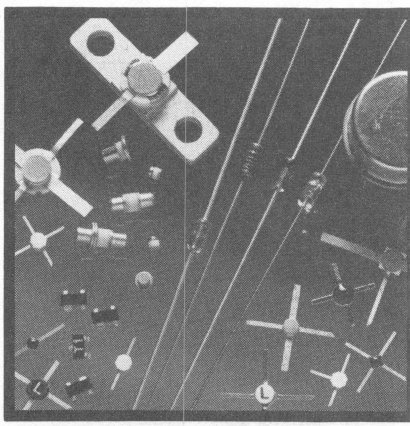


C_P = Package Capacitance
L_P = Package Inductance
R_S = Residual Series Resistance
R_I = I-Layer Resistance
C_I = I-Layer Capacitance

TYPICAL VALUES FOR C_P AND L_P ARE GIVEN UNDER "MECHANICAL SPECIFICATIONS". WITH REVERSE BIAS, R_I ~ 10k Ω. TOTAL CAPACITANCE IS C_T AND IS GIVEN IN "ELECTRICAL SPECIFICATIONS". WITH FORWARD BIAS C_I IS NO LONGER PRESENT. R_I DECREASES WITH INCREASING FORWARD BIAS TO APPROXIMATELY ZERO AT 100 mA.

Figure 5. Device Equivalent Circuit.

High Reliability Data for PIN Diodes



HEWLETT PACKARD

HIGH RELIABILITY BEAM LEAD PIN DIODES

(Generic HPND-4001/-4050)

HPND-4001TXV
(TXVP-4001)
HPND-4050TXV
(TXVP-4050)

Features

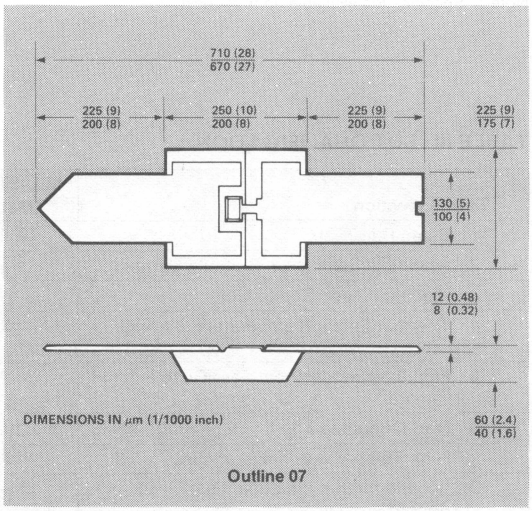
QUALITY PERFORMANCE TESTED
Test Program Patterned After MIL-S-19500

LOW SERIES RESISTANCE
1.3 Ω Typical

LOW CAPACITANCE
0.07 pF Typical

FAST SWITCHING
2 ns Typical

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull



Outline 07

Description/Applications

The HPND-4001TXV and HPND-4050TXV are bean lead PIN diodes designed specifically for low capacitance, low series resistance and rugged construction. The new HP mesa process allows the fabrication of beam lead PINs with a very low RC product. A nitride passivation layer provides immunity from contaminants which would otherwise lead to I_R drift. A deposited layer provides scratch protection.

The HPND-4001TXV and HPND-4050TXV beam lead PIN diodes are designed for use in stripline or microstrip circuits. Applications include switching, attenuating, phase shifting and modulating at microwave frequencies. The low capacitance and low series resistance at low current make these devices ideal for applications in the shunt configuration.

After completion of the 100% inspection program per Table II, lot samples are subjected to the tests of Table III.

Maximum Ratings

Operating Temperature ..... -65°C to +175°C
Storage Temperature ..... -65°C to +200°C
Power Dissipation at 25°C ..... 250 mW
(Derate linearly to zero at 175°C)
Minimum Lead Strength ..... 4 grams pull on either lead

Bonding Techniques

Thermocompression bonding is recommended but welding, thermosonic bonding or conductive epoxy can also be used. For additional information, see Application Note 974, "Die Attach and Bonding Techniques for Diodes and Transistors," or Application Note 979, "The Handling and Bonding of Beam Lead Devices Made Easy".

TABLE I. ELECTRICAL SPECIFICATIONS AT $T_A = 25°C$

Part Number HPND-	Breakdown Voltage V_{BR} (V)		Series Resistance R_S (Ω)[1]		Capacitance C_T (pF)[1]		Minority Carrier Lifetime τ (ns)[1]	Reverse Recovery Time t_{rr} (ns)[1]	Reverse Current I_R (nA)	Forward Voltage V_F (V)
	Min.	Typ.	Typ.	Max.	Typ.	Max.	Typ.	Typ.	Max.	Max.
4001TXV	50	80	1.8	2.2	0.07*	0.08*	30	3	100	0.97
4050TXV	30	40	1.3	1.7	0.12	0.15	25	2	100	0.98
Test Conditions	$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$		$I_F = 10$ mA f = 100 MHz		$V_R = 10$ V *$V_R = 30$ V f = 1 MHz		$I_F = 10$ mA $I_R = 6$ mA	$I_F = 10$ mA $V_R = 10$ V	$V_R = 10$ V	$I_F = 50$ mA

Note:
1. Test performed on packaged samples.

TABLE II. 100% INSPECTION PROGRAM

Test/Inspection	Method	Conditions
1. High Temperature Storage (Stabilization Bake)	—	24 Hours at 300° C
2. Electrical Test (die probe) V_{BR}, I_R, V_F	—	See Table I
3. Visual Inspection	HP A-5956-0112-72[1]	—

Note 1. Specification available upon request.

TABLE III. LOT QUALIFICATION

Test/Inspection	MIL-STD-750 Method	Conditions	LTPD
1. Beam Pull Test	2011H[1]	4 gram min., n = 11, r = 1	20
2. Assemble Samples in Suitable Carrier	—	—	—
3. Electrical Test (Go/No Go)	—	See Table I	—
4. Thermal Shock (Temperature Cycling)	1051	10 cycles from −65° C to +200° C, 15 minutes at extremes	—
5. First Interim Electrical Test (Read and Record)	—	V_F and I_R	—
6. Non-Operating Life	1032	340 hours at 200° C	10
7. High Temperature Reverse Bias	1038	340 hours V_R = 80% of rated V_{BR}, T_C = 150° C	
8. Second Interim Electrical Test (Read, Record and Delta)	—	V_F and I_R	
9. Operating Life	1027	340 hours, f = 60 Hz, T_C = 125° C V_R = 80% of rated V_{BR}, PFM = 50 mW	10
10. Final Electrical Test (Read, Record and Delta)	—	V_F and I_R	

Note 1: Per MIL-STD-883.

Typical Parameters

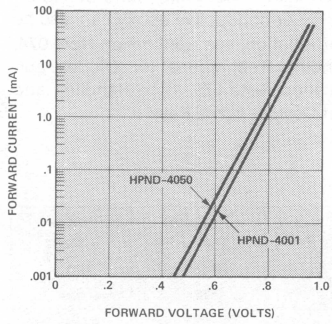


Figure 1. Typical Forward Characteristics.

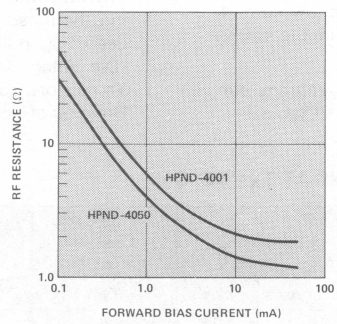


Figure 2. Typical RF Resistance vs. Forward Bias Current.

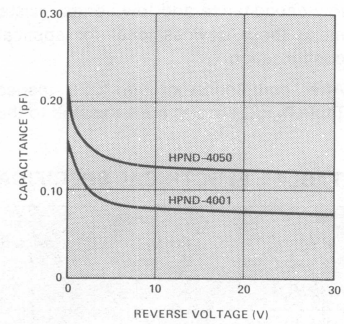


Figure 3. Typical Capacitance vs. Reverse Voltage.

HEWLETT PACKARD

HIGH RELIABILITY BEAM LEAD PIN DIODE

(Generic HPND-4005)

HPND-4005TXV
(TXVP-4005)

Features

QUALITY PERFORMANCE TESTED
Test Program Patterned After MIL-S-19500

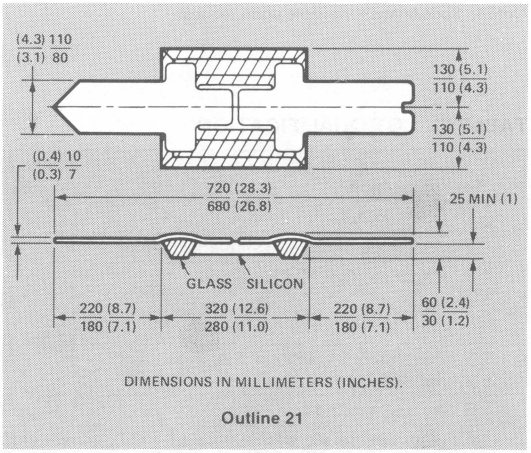
HIGH BREAKDOWN VOLTAGE
120V Typical

LOW CAPACITANCE
0.017 pF Typical

LOW RESISTANCE
4.7Ω Typical

RUGGED CONSTRUCTION
4 Grams Minimum Lead Pull

NITRIDE PASSIVATED



DIMENSIONS IN MILLIMETERS (INCHES).

Outline 21

Description/Applications

The TXVP-4005 planar beam lead PIN diodes are constructed to offer exceptional lead strength while achieving excellent electrical performance at microwave frequencies.

The TXVP-4005 beam lead PIN diode is designed for use in stripline or microstrip circuits. Applications include switching, attenuating, phase shifting, limiting and modulating at microwave frequencies. The extremely low capacitance of the TXVP-4005 makes it ideal for circuits requiring high isolation in a series diode configuration.

After completion of the 100% inspection program per Table I, lot samples are subjected to the tests of Table III.

Maximum Ratings

Operating Temperature ..... -65°C to +175°C
Storage Temperature ..... -65°C to +200°C
Power Dissipation at 25°C ..... 250 mW
(Derate linearly to zero at 175°C)
Minimum Lead Strength ..... 4 grams pull on either lead

Bonding Techniques

Thermocompression bonding is recommended but welding, thermosonic bonding or conductive epoxy can also be used. For additional information, see Application Note 974, "Die Attach and Bonding Techniques for Diodes and Transistors", or Application Note 979, "The Handling and Bonding of Beam Lead Devices Made Easy".

TABLE I. ELECTRICAL SPECIFICATIONS AT $T_A = 25°C$

Part Number	Breakdown Voltage V_{BR} (V)		Series Resistance R_S (Ω)[2]		Capacitance C_T (pF)[1, 2]		Minority Carrier Lifetime τ (ns)[2]		Reverse Recovery Time t_{rr} (ns)[2]		Forward Voltage V_F (V)	Reverse Current I_R (nA)
HPND-4005TXV	Min.	Typ.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Max.	Max.
	100	100	4.7	6.5	0.017	0.02	100	150	20	35	1.0	100
Test Conditions	$I_R = 10\ \mu A$		$I_F = 20$ mA f = 100 MHz		$V_R = 10V$ f = 10 GHz		$I_F = 10$ mA $I_R = 6$ mA		$I_F = 20$ mA $V_R = 10V$ 90% Recovery		$I_F = 10$ mA	$V_R = 30V$

Notes:
1. Total capacitance calculated from measured isolation value in a series configuration
2. Test performed on packaged samples.

TABLE II. 100% INSPECTION PROGRAM

Test/Inspection	Method	Conditions
1. High Temperature Storage (Stabilization Bake)	—	24 Hours at 300° C
2. Electrical Test (die probe) V_{BR}, I_R, V_F	—	Per Table I
3. Visual Inspection	HP A-5956-0112-72 [1]	—

Note 1. Specification available upon request.

TABLE III. LOT QUALIFICATION

Test/Inspection	MIL-STD-750 Method	Conditions	LTPD
1. Beam Pull Test	2011H [1]	4 gram min., n = 11, r = 1	20
2. Assemble Samples in Suitable Carrier	—	—	—
3. Electrical Test (Go/No Go)	—	See Table I	—
4. Temperature Cycle (Thermal Shock)	1051	10 cycles from −65° C to +200° C, 15 minutes at extremes	—
5. First Interim Electrical Test (Read and Record)	—	V_F and I_R	—
6. Non-Operating Life	1032	340 hours at 200° C, n = 65	—
7. High Temperature Reverse Bias	1038	340 hours V_R = 80% of rated V_{BR}, T_C = 150° C	10
8. Second Interim Electrical Test (Read and Record)	—	V_F and I_R	
9. Operating Life	1027	340 hours, f = 60 Hz, T_C = 125° C V_R = 80% of rated V_{BR}, PFM = 50 mW	10
10. Final Electrical Test (Read, Record)	—	V_F and I_R	

Note 1: Per MIL-STD-883.

Typical Parameters

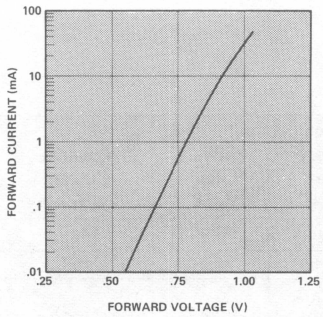


Figure 1. Typical Forward Conduction Characteristics.

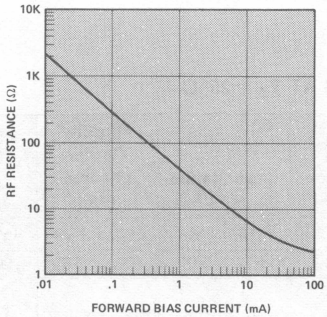


Figure 2. Typical RF Resistance vs. Forward Bias Current.

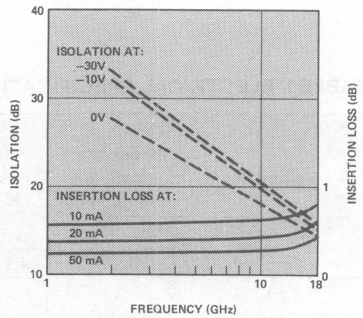


Figure 3. Typical Isolation and Insertion Loss in the Series Configuration (Z_O = 50 Ω).

HEWLETT PACKARD

PIN SWITCHING DIODE MILITARY APPROVED MIL-S-19500/443

JAN 1N5719
JANTX 1N5719

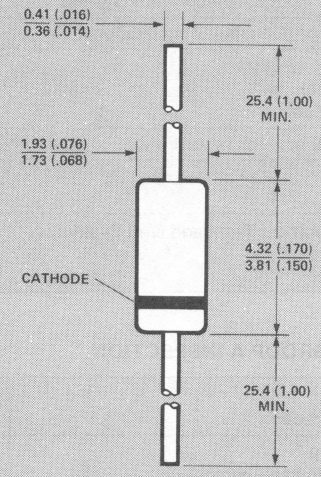
Features

QUALITY PERFORMANCE TESTED
Proven Reliability

LARGE DYNAMIC RANGE

LOW HARMONIC DISTORTION

HIGH SERIES ISOLATION



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 15

Description/Applications

The JAN Series 1N5719 is a planar passivated silicon PIN diode designed for use in RF switching circuits. These devices are well suited for variable attenuator, AGC, modulator, limiter, and phase shifter applications that require the high reliability of a JAN/JANTX device.

Maximum Ratings at $T_{CASE} = 25°C$

Operating and Storage Temperature Range ..... -65°C to +150°C
Reverse Voltage (Working) at 25°C ..... 100 V dc
Reverse Voltage (non-rep) ..... 150 V pk
Power Dissipation [At 25°C] ..... 250 mW
Derate at 2.0 mW/°C above T_{CASE} = 25°C; assumes an infinite heat sink.

TABLE I. ELECTRICAL SPECIFICATIONS AT $T_A = 25°C$
(Per Table I, Group A Testing of MIL-S-19500/443)

Part Number	Minimum Breakdown Voltage[1] V_{BR} (V)	Maximum Forward Voltage V_F (V)	Maximum Reverse Current I_{R1} (nA)	Maximum Reverse Current I_{R2} (μA)	Maximum Capacitance C_{VR} (pF)	Maximum Series Resistance R_S (Ω)	Minimum Effective Carrier Lifetime τ (ns)
1N5719	150	1.0	250	15	0.30	1.25	100
Test Conditions	I_R = 10 μA	I_F = 100 mA	V_R = 100V	V_R = 100V T_A = 150°C	V_R = 100V f = 1 MHz	I_F = 100 mA f = 100 MHz	I_F = 50 mA I_R = 250 mA

Note 1:
Tested per MIL-STD-750, Method 4021.

JAN 1N5719: Samples of each lot are subjected to Group A inspection for parameters listed in Table I, and to Group B and Group C tests listed below. All tests are to the conditions and limits specified by MIL-S-19500/443.

JANTX 1N5719: Devices undergo 100% screening tests as listed below to the conditions and limits specified by MIL-S-19500/443*. A sample of the JANTX lot is then subjected to Group A, Group B, and Group C tests as for the JAN 1N5719 above.

*JANTX devices have gold plated leads.

Table II 100% SCREENING PROGRAM (TX)

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 150° C
2. Thermal Shock (Temperature Cycling)	1051	10 Cycles, Condition F
3. Centrifuge (Constant Acceleration)	2006	20 Kg., Y_1 axis
4. Hermeticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C or E
5. Interim Electrical Tests (I_R, V_F)		See Table I
6. Burn-in	1038	I_O = 70 mA (Average), V_R = 120V (Peak) T_A = 25° C, f = 60 Hz, t = 96 hrs
7. Final Electrical Tests and Drift Evaluation (I_R, V_F) 10% P DA		ΔI_R = ±250 nA or 100% whichever is greater ΔV_F = ±100 mV

Table III GROUP A INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	V_{BR}, V_F, I_{R1}, C_{VR} and R_S per Table I	2
Subgroup 3 Dynamic Electrical Tests at 25° C	—	τ per Table I	10
Subgroup 4 High Temperature Operation (T_A = 150° C) Reverse Current (I_{R2})	4016	 Per Table I	10

Table IV GROUP B INSPECTION

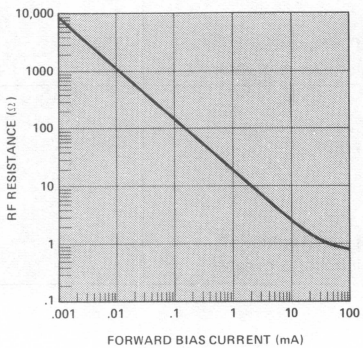
Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			15
Physical Dimensions	2066		
Subgroup 2			10
Solderability	2026	Immerse to within 0.1 inch of body	
Thermal Shock (Temperature Cycling)	1051	Test Condition F	
Thermal Shock (Glass Strain)	1056	Test Condition A	
Terminal Strength (Tension)	2036	Test Condition A, 15 secs., 4 lbs.	
Hermetic Seal	1071	Test Condition C or E	
Moisture Resistance	1021	Omit initial conditioning	
End Points:			
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4011	Per Table I	
Subgroup 3			10
Shock	2016	Non-operating, 1500G; t = 0.5 ms 5 blows in each orientation X_1, Y_1, Y_2	
Vibration Variable Frequency	2056	Non-operating	
Constant Acceleration	2006	Non-operating; 20 kg; X_1, Y_1, Y_2	
End Points:			
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4011	Per Table I	
Subgroup 4			10
Terminal Strength; Lead Fatigue	2036	Test Condition E with lead restriction	
Subgroup 5			$\lambda = 3$
High Temperature Life (Non-Operating)	1031	T_A = 150° C,[1]	
End Points:			
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4016	Per Table I	
Drift (ΔI_{R1})	—	ΔI_R = +25% of initial value or +50 nA whichever is greater	
Subgroup 6			$\lambda = 3$
Steady State Operating Life	1026	I_O = 70 mA, V_R = 120 V (Peak); f = 60 Hz,[1]	
End Points:			
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4016	Per Table I	
Drift (ΔI_{R1})	—	ΔI_R = +25% of initial value or +50 nA whichever is greater	

1. t = 1000 hours every 6 months to qualify product, t = 340 hours on each lot thereafter.

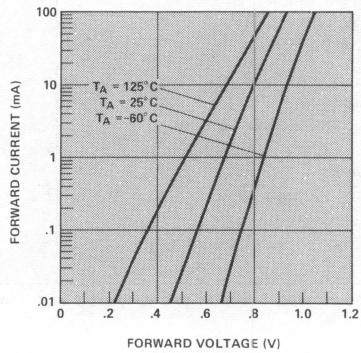
Table V GROUP C INSPECTION

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Barometric Pressure, Reduced	1001	Pressure = 15 mm Hg; t = 1 min.	20
Measurements During Test:			
Reverse Current	4016	D.C. Method. V_R = 100 V dc	
Subgroup 2			20
Salt Atmosphere (Corrosion)	1041		
Subgroup 3			20
Resistance to Solvents	—	Method 215 of MIL-STD-202	
Subgroup 4			20
Thermal Shock (Temperature Cycling)	1051	Test Condition F-1; Time at temperature extremes = 15 minutes minimum total test time = 72 hours maximum.	
End Points:			
Forward Voltage (V_F)	4011	Per Table I	
Reverse Current (I_{R1})	4016	Per Table I	
Subgroup 5			20
Low Temperature Operation (–65° C)			
Forward Voltage (V_F)	4011	< 1.15 V at I_F = 100 mA	
Breakdown Voltage (V_{BR})	4021	Per Table I	

Typical Parameters



Typical RF Resistance vs. Forward Bias Current.



Typical Forward Current vs. Forward Voltage.

HEWLETT PACKARD

HIGH RELIABILITY PIN DIODES FOR RF SWITCHING AND ATTENUATING

(Generic 5082-3001, -3002, -3039 and -3077)

TX-3001/2, TXB-3001/2, TXV-3001/2, TXVB-3001/2, TX-3039, TXB-3039, TXV-3039, TXVB-3039, TX-3077, TXB-3077, TXV-3077, TXVB-3077

Features

QUALITY PERFORMANCE TESTED
Test Program Patterned After MIL-S-19500

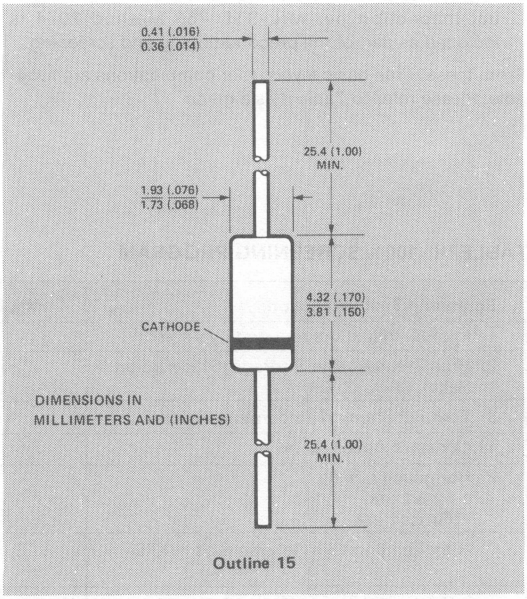
LOW HARMONIC DISTORTION

LARGE DYNAMIC RANGE

LOW SERIES RESISTANCE

LOW CAPACITANCE

LOW TEMPERATURE COEFFICIENT
Typically Less Than 20% Resistance Change from 25°C to 100°C



Outline 15

Description / Applications

These general purpose switching diodes are intended for low power switching applications such as RF duplexers, antenna switching matrices, digital phase shifters, and time multiplex filters.

The RF resistance of a PIN diode is a function of the current flowing in the diode. These current controlled resistors are specified for use in control applications such as variable RF attenuators, automatic gain control circuits, RF modulators, electrically tuned filters, analog phase shifters, and RF limiters.

Maximum Ratings

Junction Operating and Storage Temperature Range ..... -65°C to +150°C

Power Dissipation at T_{CASE} = 25°C 250mW
(Derate linearly to zero at 150°C)

Peak Inverse Voltage (PIV) ..... V_{BR}

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25°C

Part Number	Maximum Total Capacitance C_T (pF)	Minimum Breakdown Voltage V_{BR} (V)*	Maximum Residual Series Resistance R_S (Ω)	Minimum Effective Carrier Lifetime τ (ns)	Typical Reverse Recovery Time t_{rr} (ns)	Maximum Forward Voltage V_F (V)	Maximum Reverse Leakage Current I_R (nA)
5082-3002	0.20	300	1.0	100	100	1.0	100
5082-3001	0.25	200	1.0	100	100	1.0	100
5082-3039	0.25	150	1.25	100	100	1.0	100
5082-3077	0.30	200	1.5	100	100	1.0	100
Test Conditions	V_R = 50 V f = 1 MHz	$V_R = V_{BR}$ Measure I_R = 10 μA	I_F = 100 mA f = 100 MHz	I_F = 50 mA I_R = 250 mA	I_F = 20 mA V_R = 10 V 90% Recovery	I_F = 100 mA	V_R = 100 V

*Per MIL-STD-750, Method 4021.

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Table III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION.

Part Number Prefix	Screening Level
5082-	Commercial
TX-	100% Screen (per Tables III and IV)
TXB-	100% Screen and Group B (per Tables III, IV and V)
TXV-	100% Screen and Visual (per Tables III, and IV)
TXVB-	100% Screen and Group B (per Tables III, IV and V) with visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (As required by Table II)	2074	
2. High Temperature Strorage (Stabilization Bake)	1032	$t = 48$ hours, $T_A = 150°C$
3. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 cycles
4. Constant Acceleration	2006	20 Kg., Y_1 axis
5. Hermeticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. High Temperature Reverse Bias (HTRB)	1038	$t = 96$ hours, $T_A = 150°C$, $V_R = 80\%$ of rated V_{BR}
7. Interim Electrical Tests (I_R, V_F)		See Table I
8. Burn-in	1038	$t = 168$ hours, $T_A = 25°C$, PFM = 200 mW, $f = 60$ Hz, $V_{RM} = 80\%$ of rated V_{BR}.
9. Final Electrical Tests (I_R, V_F) (PDA = 10%)		$\Delta I_R < \pm 50$ nA or 100%, whichever is greater. $\Delta V_F < 10\%$

TABLE IV. GROUP A PROGRAM

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	See Table I for Tests and Conditions	5
Subgroup 3 Dynamic Electrical Tests at 25° C	—	See Table I for Tests and Conditions	5

TABLE V. GROUP B PROGRAM

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to Solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
D.C. Electrical Tests (I_R and V_F)		See Table I	
Subgroup 3			
Steady State Operating Life	1027	t = 340 hours, T_A = 25° C, PFM = 200 mW, f = 60 Hz, V_{RM} = 80% of rated V_{BR}	5
D.C. Electrical Tests (I_R and V_F)			
Subgroup 4			
Decap Internal Visual (Design Verification)	2075	One Device Only	
Subgroup 5			
High Temperature Life (Non-Operating)	1032	t = 340 hours, T_A = 150° C	7
D.C. Electrical Tests (I_R and V_F)		See Table I	

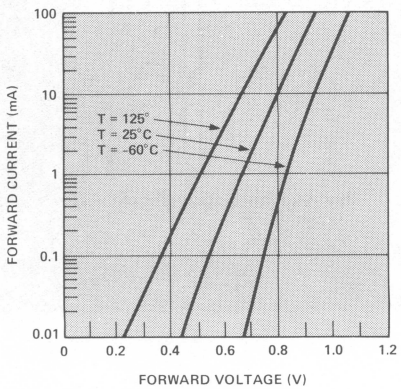


Figure 1. Typical Forward Current vs. Forward Voltage.

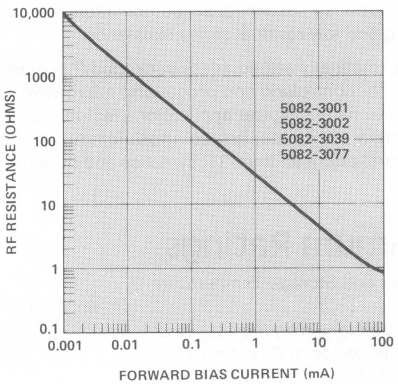


Figure 2. Typical RF Resistance vs. Forward Bias Current.

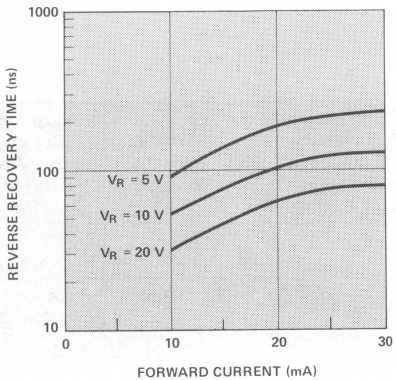


Figure 3. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages.

HEWLETT PACKARD

HIGH RELIABILITY PIN DIODES

(Generic 5082-3042 and -3043)

TX-3042 TX-3043
TXB-3042 TXB-3043
TXV-3042 TXV-3043
TXVB-3042 TXVB-3043

Features

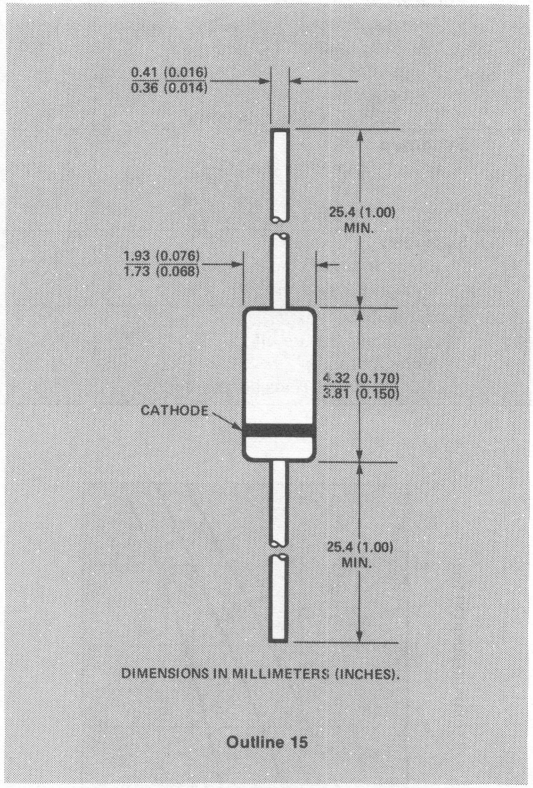
QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

FAST SWITCHING
10 ns Maximum

LOW SERIES RESISTANCE
1.5 Ω Maximum

LOW CAPACITANCE
0.4 pF Maximum

LOW DRIVE CURRENT REQUIRED
Less than 20 mA for 1Ω R_S



Outline 15

Description/Applications

The TX-3042 and -3043 are oxide passivated silicon PIN diodes of mesa construction. Precisely controlled processing provides an exceptional combination of fast RF switching and low residual series resistance.

These hermetically sealed, glass packaged PIN diodes are intended for controlling and processing microwave signals through Ku band. Typical applications include single and multi-throw switches, pulse modulators, amplitude modulators, phase shifters, TR switches and duplexers.

Maximum Ratings

Operating and Storage Temperature Range ..... -65° C to +150° C
Reverse Voltage (Working) ..... Rated V_{BR}
Power Dissipation at T_{CASE} = 25° C ..... 250 mW
(Derate linearly to zero at 150° C)
Package 15 Maximum Solder Temperature ..... 230° C for 5 seconds

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C

Part Number	Minimum Breakdown Voltage V_{BR} (V)	Maximum Total Capacitance CT-20 (pF)	Maximum Residual Series Resistance R_S (Ω)	Typical Effective Carrier Lifetime τ (ns)	Maximum Reverse Recovery Time t_{rr} (ns)	Maximum Forward Voltage V_F (V)	Maximum Reverse Leakage Current I_R (nA)
5082-3042	70	0.4	1.0	15	5	1	100
5082-3043	50	0.4	1.5	15	10	1	100
Test Conditions	$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$	V_R = 20 V f = 1 MHz	I_F = 20 mA f = 100 MHz	I_F = 50 mA I_R = 250 mA	I_F = 20 mA V_R = 10 V 90% Recovery	I_F = 100 mA	V_R = 80% Rated V_{BR}

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Table III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION.

Part Number	Screening Level
5082-3042 5082-3043	Commercial
TX-3042 TX-3043	100% Screen (per Tables III and IV)
TXB-3042 TXB-3043	100% Screen and Group B (per Tables III, IV and V)
TXV-3042 TXV-3043	100% Screen and Visual (per Tables III and IV)
TXVB-3042 TXVB-3043	100% Screen and Group B (per Tables III, IV and V) with visual

TABLE III. 100% SCREENING PROGRAM.

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (As required by Table II)	2074	
2. High Temperature Storage (Stab. Bake)	1032	$t = 48$ hours, $T_A = 150°C$
3. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 Cycles
4. Constant Acceleration	2006	20 Kg., Y_1 axis
5. Hermeticity (Seal Tests) Fine Leak Gross Leak	1071	 Condition H Condition C
6. HTRB	1038	$t = 48$ hours, $T_A = 150°C$, $V_R = 80\%$ of rated V_{BR}
7. Interim Electrical Tests (I_R, V_F)		See Table I
8. Burn-In	1038	$t = 168$ hours, $T_A = 25°C$, PFM = 200 mW, f = 60 Hz, $V_{RM} = 80\%$ of rated V_{BR}
9. Final Electrical Tests (I_R, V_F)		$\Delta I_R \leq \pm 50$ nA or 100%, whichever is greater. $\Delta V_F \leq \pm 10\%$.

TABLE IV. GROUP A PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25°C	—	See Table I for tests and conditions.	5
Subgroup 3 Dynamic Electrical Tests at 25°C	—	See Table I for tests and conditons.	5

TABLE V. GROUP B PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 3			
Steady State Operating Life	1027	t = 340 hours, T_A = 25° C, PFM = 200 mW, f = 60 Hz, V_{RM} = 80% of rated V_{BR}	5
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 4			
Decap Internal Visual (Design Verification)	2075	One Device Only	
Subgroup 5			
High Temperature Life (Non-Operating)	1032	t = 340 hours, T_A = 150° C	7
DC Electrical Tests (I_R and V_F)		See Table I.	

HEWLETT PACKARD

HIGH RELIABILITY PIN ATTENUATOR DIODES

(Generic 5082-3080)

TX-3080
TXB-3080
TXV-3080
TXVB-3080

Features

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

LOW DISTORTION

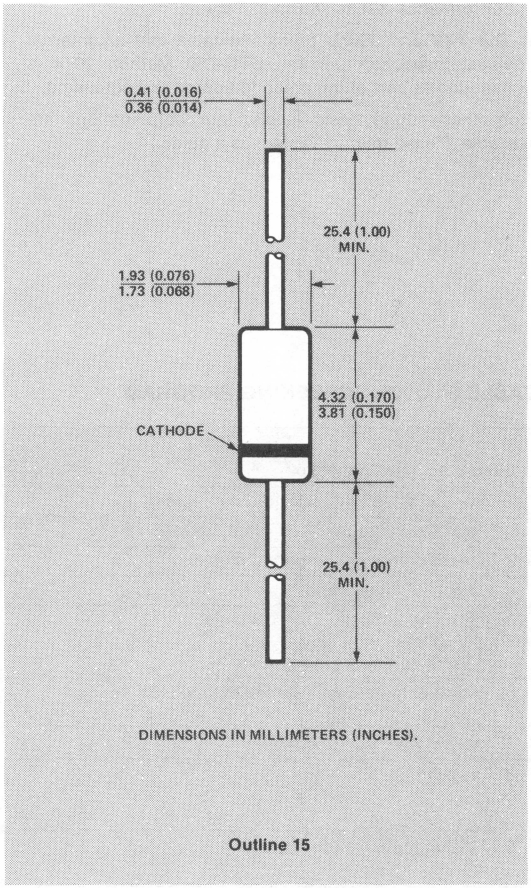
HERMETICALLY SEALED GLASS PACKAGE

USEFUL DOWN TO 1 MHz

TIGHT RESISTANCE TRACKING BETWEEN UNITS

SPECIFIED RF RESISTANCE WITH BIAS

LOW TEMPERATURE COEFFICIENT



Outline 15

Description/Applications

The TX-3080 passivated silicon planar diffused PIN diode is specially tested as an RF current controlled resistor. The long minority carrier lifetime assures usefulness at operating frequencies down to 1 MHz, with very low distortion. Tightly controlled fabrication process for RF resistance variation with bias makes these diodes ideally suited for constant impedance AGC-circuits, leveling circuits, electronically controlled RC and RL circuits, pi-, T-, or bridged T- attenuators operating between 1 MHz to 1 GHz with very low distortion.

Maximum Ratings

Operating and Storage Temperature Range ..... -65° C to +150° C
Reverse Voltage (Working) ..... 100 V(peak)
Power Dissipation at T_{CASE} = 25° C ..... 250 mW
(Derate linearly to zero at 150° C)
Package 15 Maximum Solder Temperature ..... 230° C for 5 seconds

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C

Part Number	Minimum Breakdown Voltage V_{BR} (V)	Maximum Total Capacitance C_T (pF)	Typical Effective Minority Carrier Lifetime τ (ns)	Maximum Residual Series Resistance R_S (Ω)	Minimum High Resistance Limit R_H (Ω)	Maximum Low Resistance Limit R_L (Ω)	Maximum Forward Voltage V_F (V)	Maximum Reverse Leakage Current I_R (nA)
-3080	100	0.4	1300	2.5	1000	8	1	100
Test Condition	$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$	V_R = 50 V f = 1 MHz	I_F = 50 mA I_R = 250 mA	I_F = 100 mA f = 100 MHz	I_F = 0.01 mA f = 100 MHz	I_F = 20 mA f = 100 MHz	I_F = 30 mA	V_R = 50 V

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Tables III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION.

Part Number	Screening Level
5082-3080	Commercial
TX-3080	100% Screen (per Tables III and IV)
TXB-3080	100% Screen and Group B (per Tables III, IV and V)
TXV-3080	100% Screen and Visual (per Tables III and IV)
TXVB-3080	100% Screen and Group B (per Tables III, IV and V) with visual

TABLE III. 100% SCREENING PROGRAM.

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (As Required by Table II)	2074	
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 150° C
3. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 Cycles
4. Constant Acceleration	2006	20 Kg., Y_1 axis
5. Hermeticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. High Temperature Reverse Bias (HTRB)	1038	t = 48 hours, T_A = 150° C V_R = 80 V
7. Interim Electrical Tests (I_R, V_F)		See Table I
8. Burn-In	1038	t = 168 hours, T_A = 25° C, PFM = 200 mW, f = 60 Hz, V_{RM} = 80 V
9. Final Electrical Tests (I_R, V_F)		$\Delta I_R < \pm 50$ nA or 100%, whichever is greater. $\Delta V_F < 10\%$

TABLE IV. GROUP A PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	See Table I for tests and conditions.	5
Subgroup 3 Dynamic Electrical Tests at 25° C	—	See Table I for tests and conditons.	5

TABLE V. GROUP B PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 3			
Steady State Operating Life	1027	t = 340 hours, T_A = 25° C, PFM = 200 mW, f = 60 Hz, V_{RM} = 80 V	5
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 4			
Decap Internal Visual (Design Verification)	2075	One device only	
Subgroup 5			
High Temperature Life (Non-Operating)	1032	t = 340 hours, T_A = 150° C	7
DC Electrical Tests (I_R and V_F)		See Table I.	

HEWLETT PACKARD

HIGH RELIABILITY UHF/VHF SWITCHING PIN DIODES

(Generic 5082-3168 and -3188)

TX-3168 TX-3188
TXB-3168 TXB-3188
TXV-3168 TXV-3188
TXVB-3168 TXVB-3188

Features

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

LOW SERIES RESISTANCE

LOW CAPACITANCE

HERMETIC PACKAGE

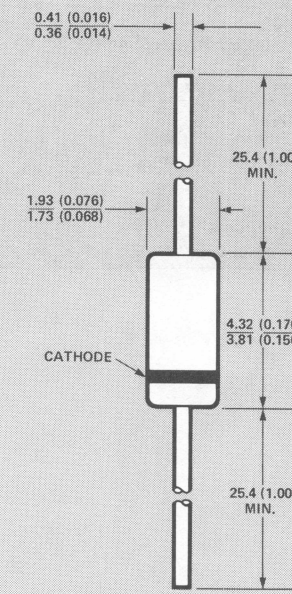
Description/Applications

The TX-3168 and -3188 are passivated silicon PIN diodes designed for optimal VHF/UHF switching characteristics. These devices switch rapidly between high and low values of RF impedance as a function of DC bias current.

These PIN diodes are designed for use in VHF/UHF band switching and general purpose RF switching that require high performance, and mechanical and environmental reliability.

Maximum Ratings

Operating and Storage Temperature Range ..... -65° C to +150° C
Reverse Voltage (Working) ..... 35 V
Power Dissipation at T_{CASE} = 25° C ..... 250 mW
(Derate linearly to zero at 150° C)
Package 15 Maximum Solder Temperature ..... 230° C for 5 seconds



DIMENSIONS IN MILLIMETERS (INCHES).

Outline 15

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C

Part Number	Minimum Breakdown Voltage V_{BR} (V)	Maximum Total Capacitance C_T (pF)	Maximum Residual Series Resistance R_S (Ω)	Typical Effective Carrier Lifetime τ (ns)	Typical Reverse Recovery Time t_{rr} (ns)	Maximum Forward Voltage V_F (V)	Maximum Reverse Current I_R (nA)
5082-3168	35	2.0	0.5	40	12	1	100
5082-3188	35	1.0	0.6	40	12	1	100
Test Conditions	I_R = 10 μA	V_R = 20 V f = 1 MHz	I_F = 10 mA f = 100 MHz	I_F = 50 mA I_R = 250 mA	I_F = 20 mA V_R = 10 V 90% recovery	I_F = 100 mA	V_R = 20 V

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Tables III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION.

Part Number	Screening Level
5082-3168 5082-3188	Commercial
TX-3168 TX-3188	100% Screen (per Tables III and IV)
TXB-3168 TXB-3188	100% Screen and Group B (per Tables III, IV and V)
TXV-3168 TXV-3188	100% Screen and Visual (per Tables III and IV)
TXVB-3168 TXVB-3188	100% Screen and Group B (per Tables III, IV and V) with visual

TABLE III. 100% SCREENING PROGRAM.

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (As Required by Table II)	2074	
2. High Temperature Storage (Stab. Bake)	1032	t = 48 hours, T_A = 150° C
3. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 Cycles
4. Constant Acceleration	2006	20 Kg., Y_1 axis.
5. Hermeticity Fine Leak Gross Leak	1071	 Condition H Condition C
6. High Temperature Reverse Bias (HTRB)	1038	t = 48 hours, T_A = 150° C, V_R = 28 Volts Max.
7. Interim Electrical Tests (I_R, V_F)		See Table I
8. Burn-In	1038	t = 168 hours, T_A = 25° C, PFM = 200 mW, f = 60 Hz, V_{RM} = 28 Volts
9. Final Electrical Tests (I_R, V_F)		$\Delta I_R \leq \pm 50$ nA or 100%, whichever is greater. $\Delta V_F \leq \pm 10\%$.

TABLE IV. GROUP A PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	See Table I for tests and conditions.	5
Subgroup 3 Dynamic Electrical Tests at 25° C	—	See Table I for tests and conditions.	5

TABLE V. GROUP B PROGRAM.

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 3			
Steady State Operating Life	1027	t = 340 hours, T_A = 25° C, PFM = 200 mW, f = 60 Hz, V_{RM} = 28 V	5
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 4			
Decap Internal Visual (Design Verification)	2075	One device only.	
Subgroup 5			
High Temperature Life (Non-Operating)	1032	t = 340 hours, T_A = 150° C	7
DC Electrical Tests (I_R and V_F)		See Table I.	

HEWLETT PACKARD

HIGH RELIABILITY PIN DIODES FOR STRIPLINE AND MICROSTRIP SWITCHES, ATTENUATORS, AND LIMITERS

(Generic 5082-3141)

TX-3141
TXB-3141
TXV-3141
TXVB-3141

Features

QUALITY PERFORMANCE TESTED
Test Program Patterned after MIL-S-19500

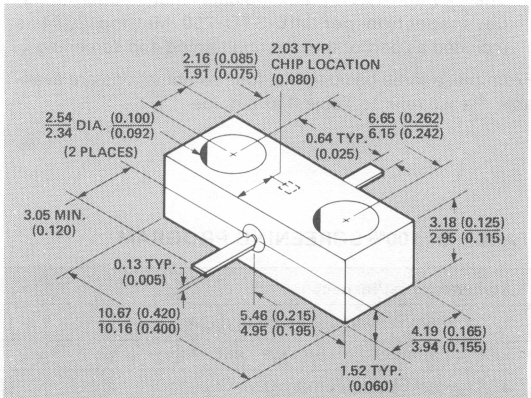
BROADBAND OPERATION
HF through X-band

LOW INSERTION LOSS
Less than 1.0 dB to 8 GHz

HIGH ISOLATION
Greater than 20 dB to 8 GHz

FAST SWITCHING/MODULATING
5 ns Typical

LOW DRIVE CURRENT REQUIRED
Less than 20 mA for 20 dB Isolation



DIMENSIONS IN MILLIMETERS AND (INCHES)

Outline 60

Description/Applications

The 5082-3141 is a specially processed oxide passivated mesa PIN diode in shunt configuration within a 50 Ω hermetic package (Outline 60), optimized for good continuity of characteristic impedance, which allows a continuous transition when used in 50 Ω stripline or microstrip circuits. The stripline package overcomes the limitations in insertion loss, isolation, and bandwidth that are imposed by package parasitics of the other packages. The TX-3141 is recommended for applications requiring fast switching or high frequency signal modulation or where low bias current for maximum attenuation is required.

Maximum Ratings

Operating and Storage Temperature Range ..... −65° C to 150° C
Reverse Voltage (Working) ..... 70 V
Power Dissipation at T_{CASE} = 25° C ..... 250 mW
(Derate linearly to zero at 150° C)
Peak Incident Pulse Power ..... 50 W
(t_p = 1 μs, f = 10 GHz, Du - 0.001, Z_O = 50 Ω)

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25° C

Part Number	Heat Sink	Minimum Isolation (dB)	Maximum Insertion Loss (dB)	Maximum SWR	Maximum Reverse Recovery Time (t_{rr}) (ns)	Typical Carrier Lifetime (ns)	Forward Voltage V_F (V)	Reverse Current I_R (nA)
5082-3141	Cathode	20	1.0	1.5:1	10	15	1.0	100
Test Conditions		I_F = 20 mA f = 8 GHz	I_F = 0 P_{IN} = 1 mW f = 8 GHz	I_F = 0 P_{IN} = 1 mW f = 8 GHz	I_F = 20 mA V_R = 10 V Recovery to 90%	I_F = 50 mA I_R = 250 mA	I_F = 50 mA	V_R = 50 V

High Reliability Programs

Three basic levels of High-Rel testing are offered.

1. The TX prefix indicates a part that is preconditioned and screened to the program shown in Table III and IV.
2. The TXB prefix identifies a part that is preconditioned and screened to TX level with a Group B quality conformance test as shown in Table V.
3. The TXV and TXVB prefix indicates that an internal visual inspection per MIL-STD-750 Method 2074 is included as part of the preconditioning and screening.

From these three basic levels, four combinations are available. Please refer to Table II as a guide.

TABLE II. PART NUMBER SYSTEM FOR ORDER AND RFQ INFORMATION

Part Number	Screening Level
5082-3141	Commercial
TX-3141	100% Screen (per Table III and IV)
TXB-3141	100% Screen and Group B (per Table III, IV, and V)
TXV-3141	100% Screen and Visual (per Table III, and IV)
TXVB-3141	100% Screen and Group B (per Table III, IV, and V) with Visual

TABLE III. 100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-750 Method	Conditions/Comments
1. Internal Visual (As required by Table II)	2074	
2. High Temperature Storage (Stabilization Bake)	1032	t = 48 hours, T_A = 150° C
3. Thermal Shock (Temperature Cycling)	1051	Condition F, 10 Cycles
4. Constant Acceleration	2006	20 Kg., Y_1 axis
5. Hermeticity Tests Fine Leak Gross Leak	1071	 Condition H Condition C
6. High Temperature Reverse Bias (HTRB)	1038	t = 48 hours, T_A = 150° C, V_R = 56 V
7. Interim Electrical Tests (I_R, V_F)		See Table I
8. Burn-In	1038	t = 168 hours, T_A = 25° C, PFM = 200 mW, V_{RM} = 56 V
9. Final Electrical Tests (I_R, V_F)		$\Delta I_R \leq \pm 50$ nA or 100%, whichever is greater. $\Delta V_F \leq \pm 10\%$.

TABLE IV. GROUP A PROGRAM

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1 Visual and Mechanical	2071		5
Subgroup 2 DC Electrical Tests at 25° C	—	See Table I for tests and conditions.	5
Subgroup 3 Dynamic Electrical Tests at 25° C	—	See Table I for tests and conditons.	5

TABLE V. GROUP B PROGRAM

Test/Inspection	MIL-STD-750 Method	Conditions/Comments	LTPD
Subgroup 1			
Solderability	2026		15
Resistance to solvents	1022		
Subgroup 2			
Thermal Shock (Temperature Cycling)	1051	Condition F1 (25 cycles)	10
Hermetic Seal	1071		
Fine Leak		Condition H	
Gross Leak		Condition C	
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 3			
Steady State Operating Life	1027	t = 340 hours, T_A = 25° C, PFM = 200 mW, V_{RM} = 56 V	5
DC Electrical Tests (I_R and V_F)		See Table I.	
Subgroup 4			
Decap Internal Visual (Design Verification)	2075	One device only.	
Die Shear	2017		20
Subgroup 5			
High Temperature Life (Non-Operating)	1032	t = 340 hours, T_A = 150° C	7
DC Electrical Tests (I_R and V_F)		See Table I.	

HEWLETT PACKARD

HIGH RELIABILITY FAST SWITCHING BEAM LEAD PIN DIODES FOR PHASED ARRAYS

HPND-4028TXV
HPND-4038TXV

Features

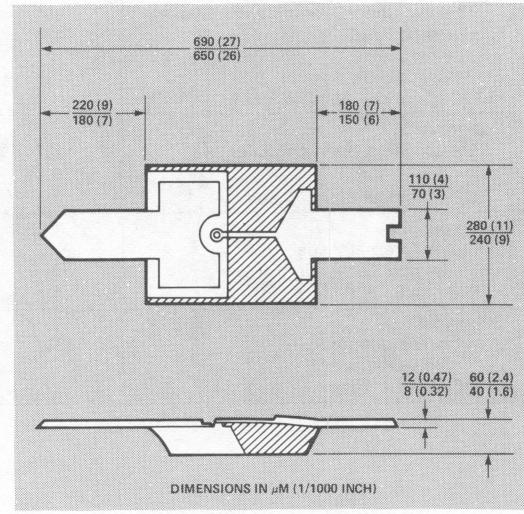
LOW CAPACITANCE
Guaranteed Minimum/Maximum

LOW RESISTANCE AT LOW BIAS
1.5 ohms at I_F = 10 mA

FAST SWITCHING
2.4 nsec

RUGGED CONSTRUCTION

SILICON NITRIDE PASSIVATION



Description

The HPND-4028TXV and HPND-4038TXV beam lead PIN diodes are designed for low capacitance, low resistance, and fast switching at microwave frequencies. These characteristics are achieved at low bias levels for minimal power consumption. Advanced processing techniques ensure uniform and consistent electrical performance allowing guaranteed capacitance windows. This translates to improved circuit performance in phased array applications.

Rugged construction and strong beams ensure high assembly yields while nitride passivation and polyimide coating ensure device reliability.

Applications

These beam lead PIN diodes are designed for use in stripline, coplanar waveguide, or microstrip circuits. Applications include phase shifting and switching. The guaranteed capacitance windows ensure uniform performance in phased array radar. The low capacitance makes them ideal for circuits requiring high isolation in the series configuration.

Maximum Ratings

Operating Temperature . . . . . -65°C to +150°C
Storage Temperature . . . . . -65°C to +200°C
Power Dissipation at T_{CASE} = 25°C . . . . . 250 mW
(Derate linearly to zero at 150°C)
Minimum Lead Strength . . . . . 4 grams pull on either lead

Assembly Techniques

Thermocompression bonding is recommended. Welding, ultrasonic bonding, solder, or conductive epoxy may also be used. For additional information see Application Note 979, "The Handling and Bonding of Beam Lead Devices Made Easy", or Application Note 992, "Beam Lead Attachment Methods", or Application Note 993, "Beam Lead Device Bonding to Soft Substrates".

TABLE I. ELECTRICAL SPECIFICATIONS AT T_A = 25°C

	Capacitance C_T (pF)		Series Resistance R_S (Ω)			Breakdown Voltage V_{BR} (V)	Carrier Lifetime (ns)		Reverse Recovery Time t_{rr} (ns)	
Part Number	Min.	Max.	Typ.	Max	Typ.	Min.	Typ.	Max.	Typ.	Max.
HPND-4028TXV	0.025	0.045	2.3	3.0	2.0	60	36	50	2.6	4.0
HPND-4038TXV	0.045	0.065	1.5	2.0	1.0	60	45	60	2.4	3.0
Test Conditions	V_R = 30 V f = 1 MHz		I_F = 10 mA f = 100 MHz		I_F = 50 mA f = 100 MHz	I_F = 50 mA f = 100 MHz	I_F = 10 mA I_F = 6 mA		I_F = 5 mA V_R = 10 V 90% Recovery	

Typical Parameters (Series Configuration)

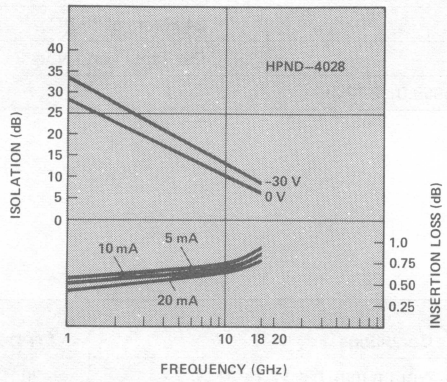


Figure 1. Typical Isolation and Insertion Loss (HPND-4028TXV)

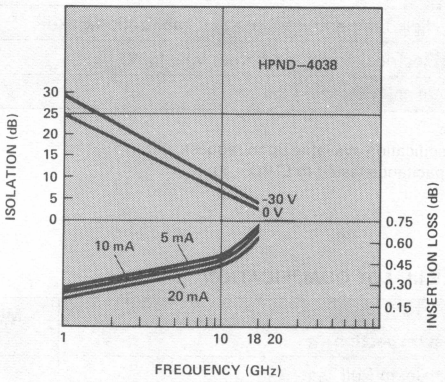


Figure 2. Typical Isolation and Insertion Loss (HPND-4038TXV)

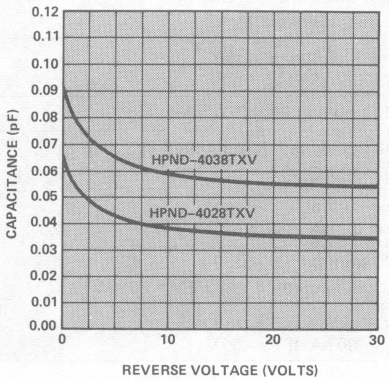


Figure 3. Typical Capacitance vs. Reverse Voltage (at 1 MHz)

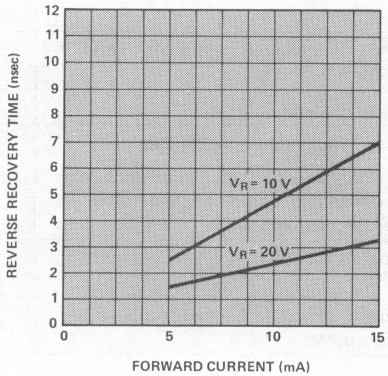


Figure 4. Typical Reverse Recovery Time vs. Forward Current (Series Configuration) (HPND-4028TXV, -4038TXV)

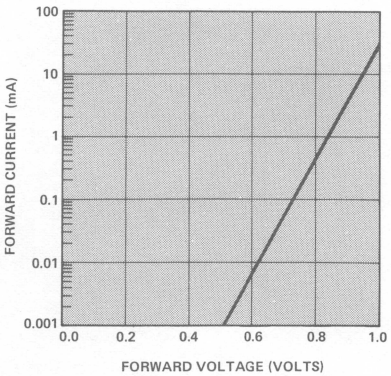


Figure 5. Typical Forward Characteristics (HPND-4028TXV, -4038TXV)

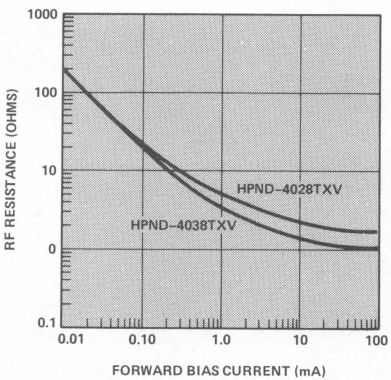


Figure 6. Typical RF Resistance vs. Forward Bias Current (at 100 MHz)

TABLE II. 100% INSPECTION PROGRAM

Test/Inspection	Method	Conditions
1. High Temperature Storage (Stabilization Bake)	—	24 Hours at 300°C
2. Electrical Tests (die probe) V_{BR}, I_R, V_F	—	Per Table I and Note 2.
3. Visual Inspection	HP A-5956-0112-72[1]	—

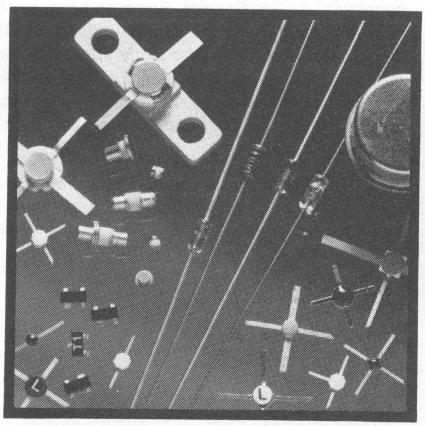
Notes:
1. Specification available upon request.
2. Capacitance tested to LTPD = 10.

TABLE III. LOT QUALIFICATION

Test Inspection	MIL-STD-750 Method	Conditions	LTPD
1. Beam Pull Test	2011H[1]	4 gram min, n = 11, r = 1	20
2. Assemble Samples in Suitable Carrier	—	—	—
3. Electrical Test (Go/No Go)	—	See Table I	—
4. Temperature Cycle (Thermal Shock)	1051	10 cycles from -65°C to 200°C 15 minutes at extremes	—
5. First Interim Electrical Test (Read and Record) V_F and I_R	—	$V_F < 1.1$ V at $I_F = 20$ mA $I_R < 100$ nA at $V_R = 50$ V	—
6. Non-Operating Life	1032	340 hours at 200°C, n = 65	—
7. High Temperature Reverse Bias	1038	340 hours, V_R = 80% of rated V_{BR}, $T_A = 125°C$	10
8. Second Interim Electrical Test (Read and Record) V_F and I_R	—	$V_F < 1.1$ V at $I_F = 20$ mA $I_R < 100$ nA at $V_R = 50$ V	
9. Operating Life	1027	340 hours, f = 60 Hz, $T_A = 125°C$ V_R = 80% of rated V_{BR}, PFM = 50 mW	10
10. Final Electrical Test (Read and Record) V_F and I_R	—	$V_F < 1.1$ V at $I_F = 20$ mA $I_R < 100$ nA at $V_R = 50$ V	

Note:
1. Per MIL-STD-883.

Reliability Data for PIN Diodes



HEWLETT PACKARD

RELIABILITY BULLETIN
PIN BEAM LEAD DIODES

Conclusion

Hewlett-Packard's beam lead diodes have successfully passed stringent environmental testing. Therefore, it is recommended that Hewlett-Packard beam lead diodes be used in military and space applications without the necessity of hermetically sealed packaging.

General

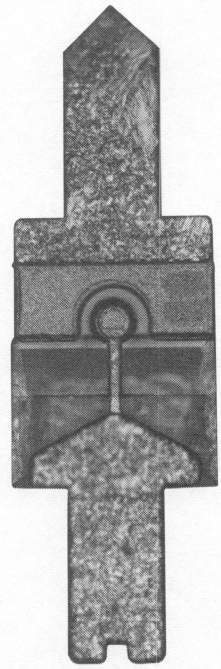
For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests run to demonstrate that a product meets the specified design criteria. All PIN beam lead families have fulfilled the standard requirements of reliability qualification, and the results of these tests are available upon request from Hewlett-Packard.

Program Description

The purpose of this program is to qualify all beam lead diodes for operation in extreme environmental conditions which may be encountered during military and space operations.

The following test sequence has been designed to assess the endurance of beam lead diodes through relevant environmental stresses such as heat and humidity. To qualify a device as hermetic, the conventional procedure is to perform dye-penetrant and Radiflo tests. However, because of the absence of an enclosed cavity in the unique design of the beam lead diode, these tests are not directly applicable. Therefore, this program utilizes reliability tests such as moisture resistance, salt atmosphere, and immersion to verify that the passivation layer on the beam lead acts as a seal to protect the active area of the diode.

To perform these tests, various PIN diodes were mounted in non-hermetic, open packages and tested as exposed beam lead devices.



Typical Beam Lead Outline

Applicable Part Numbers

PIN Beam Leads

HPND-4001
HPND-4005
HPND-4028
HPND-4038
HPND-4050

Test Sequence

Test	MIL-STD-750	Test Conditions	LTPD
Moisture Resistance[1,2]	1021	98% R.H. –10° C to 65° C, 10 days	
Temperature Cycling	1051	–65° C to 200° C, 100 cyc.	7
Constant Acceleration	2006	20 KG, 1 min. each axis	
Salt Atmosphere[2]	1041	35° fog, 24 hours	10
Salt Water Immersion[2]	(MIL-STD-883, M1002B)	65° C saturated NaCl solution, 2 cycles	10

Notes:
1. The sequence of moisture resistance and temperature cycling followed by constant acceleration assures a thorough evaluation of the effect of exposure to high humidity and heat conditions. End points were taken after each test.
2. End points were: Visual at 100X magnification and D.C. testing to MIL-STD-19500.

Results

As demonstrated by these tests, Hewlett-Packard's beam lead diodes exhibit superior performance when subjected to severe environmental conditions. This proven reliability is achieveable because of Hewlett-Packard's unique beam lead design. These beam lead diodes are made of tri-metal (Ti-Pi-Au) which extends both the operating and storage temperature range. In addition, a nitride passivation layer acts as a sealant and provides immunity from contaminants which could lead to I_R drift. Conductive particle protection is provided by a layer of polymide, which also functions as scratch protection. Therefore, it is recommended that Hewlett-Packard beam lead diodes be used in military and space applications without the necessity of hermetically sealed packaging.

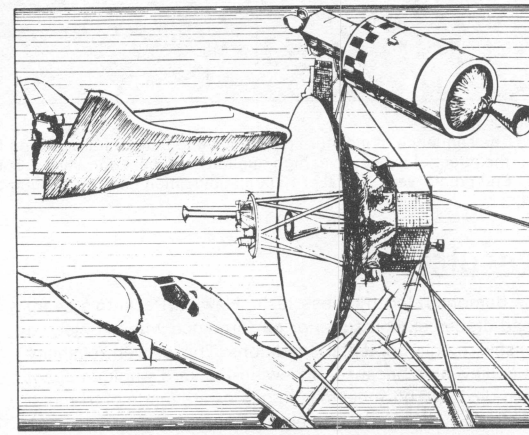
HEWLETT PACKARD

RELIABILITY DATA BEAM LEAD PIN DIODES

HPND-4005

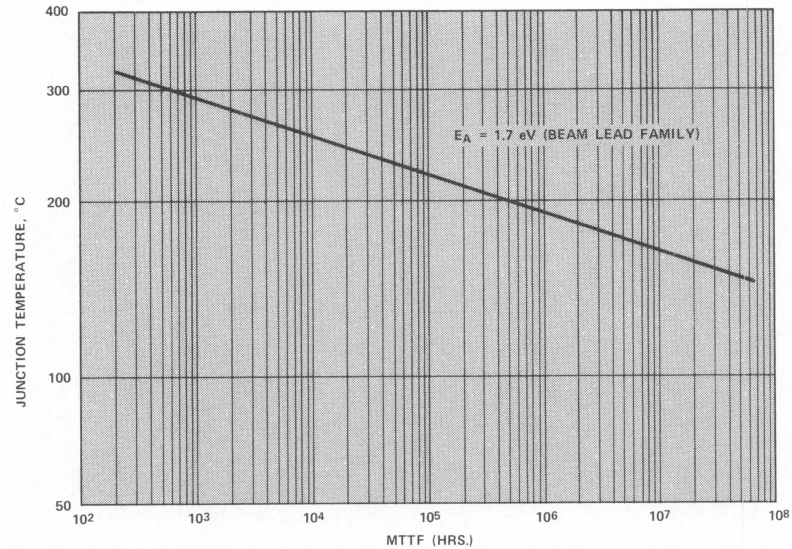
Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is initially compiled from reliability tests run prior to market introduction to demonstrate that a product meets design criteria. Additional tests are run periodically. The data on this sheet represents the latest review of accumulated test results.



Applications

This information represents the capabilities of the generic device. Failure rates and MTTF values presented here are achievable with normal MIL-S-19500 TX level screening. Reliability can only be guaranteed by testing specified lots of devices, under specified conditions, with specified LTPD levels.



Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions	LTPD/1000 Hours
High Temperature Life	1,000 hrs. min. storage time @ 200° C	2.0
Steady State Operating Life	1,000 hrs. min. operating time @ I_F = 30 mA, T_A = 150° C	2.0

Environmental

Test	MIL-STD-750 Reference	Test Conditions	LTPD
Temperature Cycling	1051.1 Cond. B	10 cycles from −65° C to +200° C, 30 min. at extremes, 5 min. transfer	4
Thermal Shock	1056.1	10 cycles from 0° C to +100° C, 3 sec. transfer	6
Soldering Heat	2031	10 seconds at 260° C	15
Shock	2016.1	5 blows each at X_1, Y_1, Y_2, 1500 G, 0.5 msec pulse	5
Vibration Fatigue	2046	32 ± 8 hrs. each at X, Y, Z, 96 hr. total, 60 Hz, 20 G min.	5

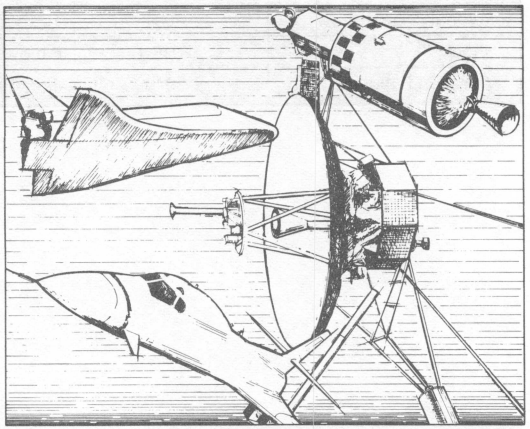
HEWLETT PACKARD

RELIABILITY DATA PIN DIODES

1N5767
5082-3080
5082-3168
5082-3188

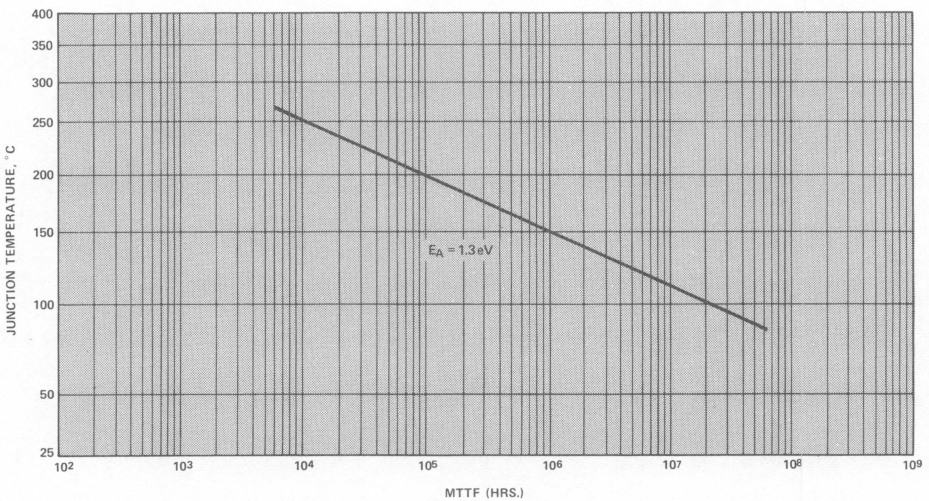
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Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions	LTPD/1000 Hours
High Temperature Life	1,000 hrs. min. storage time @ 150° C	2
Steady State Operating Life	1,000 hrs. min. operating time @ P_{FM} = 250 mW, V_{RM} = 20 V, f = 60 Hz, T_A = 25° C	2

Environmental

Test	MIL-STD-750 Reference	Test Conditions	LTPD
Solderability	2026	Sn 60, Pb 40, solder at 230° C	6
Temperature Cycling	1051.1 Cond. B	10 cycles from −65° C to +150° C, 0.5 hrs. at extremes, 5 min. transfer	7
Thermal Shock	1056.1	5 cycles from 0° C to +100° C, 3 sec. transfer	6
Moisture Resistance	1021.1	10 days, 90-98% RH, −10 to +65° C, non operating	5
Shock	2016.1	5 blows each X_1, Y_1, Y_2, 1500 G. 0.5 msec pulse	6
Vibration Fatigue	2046	32 ± 8 hrs, each X, Y, Z, 96 hr. total, 60 Hz, 20 G min.	5
Vibration Variable Frequency	2056	4, 4 minute cycles each X, Y, Z, at 20 G min. 100 to 2000 Hz	5
Constant Acceleration	2006	1 minute each X_1, Y_1, Y_2, at 20,000 G	5
Terminal Strength	2037.1 Cond. E	Miniature glass package, −3, 90° arcs, 2 leads, 8 oz., lead restriction	6
Salt Atmosphere	1041.1	35° fog for 24 hours	7

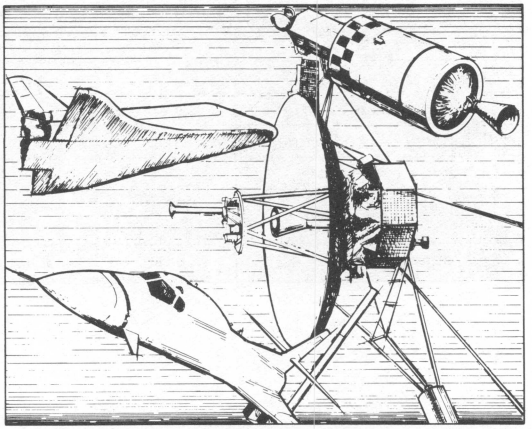
HEWLETT PACKARD

RELIABILITY DATA PIN DIODES

1N5719
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5082-3002
5082-3039
5082-3077
HPND-4165
HPND-4166

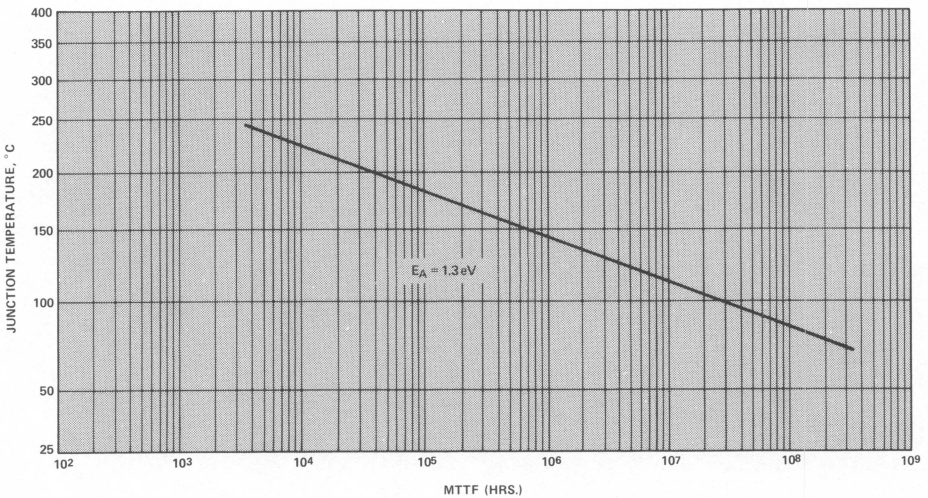
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Mean Time to Failure vs. Junction Temperature

Burn-In and Storage

Test	Test Conditions	LTPD/1000 Hours
High Temperature Life	1,000 hrs. min. storage time @ 150° C	2
Steady State Operating Life	1,000 hrs. min. operating time @ P_{FM} = 250 mW. $V_{RM} \approx$ 150 V, f = 60 Hz, T_A = 25° C	2

Environmental

Test	MIL-STD-750 Reference	Test Conditions	LTPD
Solderability	2026	Sn 60, Pb 40, solder at 230° C	5
Temperature Cycling	1051.1 Cond. B	5 cycles from −65° C to +150° C, 0.5 hrs. at extremes, 5 min. transfer	5
Thermal Shock	1056.1	5 cycles from 0° C to +100° C, 3 sec. transfer	8
Moisture Resistance	1021.1	10 days, 90-98% RH, −10 to +65° C, non-operating	5
Shock	2016.1	5 blows each X_1, Y_1, Y_2, 1500 G. 0.5 msec pulse	5
Vibration Variable Frequency	2056	4, 4 minute cycles each X, Y, Z, at 20 G min. 100 to 2000 Hz	5
Constant Acceleration	2006	1 minute each X_1, Y_1, Y_2, at 20,000 G	5
Terminal Strength	2037.1 Cond. E	Miniature glass package −3, 90° arcs, 2 leads, 8 oz., lead restriction	5
Hermeticity	1014	Kr-85/dry N_2 penetrant dye	2

ABSTRACTS OF APPLICATION NOTES AND BULLETINS FOR PIN DIODES

The Microwave Semiconductor Division field sales force is supported by a division applications staff. These technical specialists investigate circuit applications of most interest to the users of these semiconductor devices. The results of these investigations are reported in application notes or in brief application bulletins.

A complete list with brief abstracts is presented here. Below is a brief summary of Application Notes for PIN diodes. All of the Application Notes are available from your local HP HP Sales Office or nearest HP Components Authorized Disbributor or Representative.

922 Application of PIN Diodes
Discusses how the PIN diode can be applied to a variety of RF control circuits. Such applications as attenuating, leveling, amplitude and pulse modulating, switching, and phase shifting are discussed in detail. Also examines some of the important properties of the PIN diode and how they affect its application.

929 Fast-Switching PIN Diodes
Discusses the switching speed of the PIN diodes and the considerations which affect switching capability. For HP's 5082-3041/3042 fast-switching PIN diodes, AN 929 outlines basic drive requirements and comments on a few practical switching circuits. Considerations involved in the design of the filters required for use with the diodes are also discussed. For the 5082-3041, AN 929 provides two curves: 1) typical isolation vs. forward bias and 2) switching time vs. forward bias for peak reverse current as a parameter.

932 Selection and Use of Microwave Diode Switches and Limiters
Helps the systems designer select the proper switching or limiting component and assists him in integrating this component into the overall design of the system. This note is a practical, user-oriented approach to problems encountered with switching and limiting microwave signals.

936 High Performance PIN Attenuator for Low-Cost AGC Applications
PIN diodes offer an economical way of achieving excellent performance in AGC circuits. Significant improvements in crossmodulation and intermodulation distortion performance are obtained, compared to transistors. This note discusses other advantages of PIN diodes, such as low frequency operation, constant impedance levels, and low power consumption.

957-1 Broadbanding the Shunt PIN Diode SPDT Switch
Covers an impedance matching technique which improves the bandwidth of shunt PIN diode switches.

957-2 Reducing the Insertion Loss of a Shunt PIN Diode
Examines a simple filter design which includes the shunt PIN diode capacitance into a low pass filter, thereby extending the upper frequency limit.

957-3 Rectification Effects in PIN Attenuators
Attenuation levels of PIN diodes are changed by high incident power. Variation in attenuation may be minimized by proper choice of bias resistance. Performance of a PIN diode is limited by both carrier level and frequency because of rectification effects. This note presents the effects of frequency, power level, and bias supply for three types of HP diodes: 5082-3170, 3140 and 3141.

971 The Beam Lead Mesa PIN in Shunt Applications
The low RC product, fast switching time, and other unique features of the HPND-4050 beam lead PIN diode make it well-suited for switching applications in the shunt configuration. Switching performance, practical circuits, handling, and bonding instructions are included in this application note.

979 The Handling and Bonding of Beam Lead Made Easy
Beam Lead devices are particularly attractive for hybrid circuits because of their low parasitics and small size. The availability of equipment and techniques specifically designed for their small size has facilitated the handling and bonding of these devices. This note describes some of this equipment and techniques, and outlines suggestions for the proper handling and bonding of Beam Lead devices.

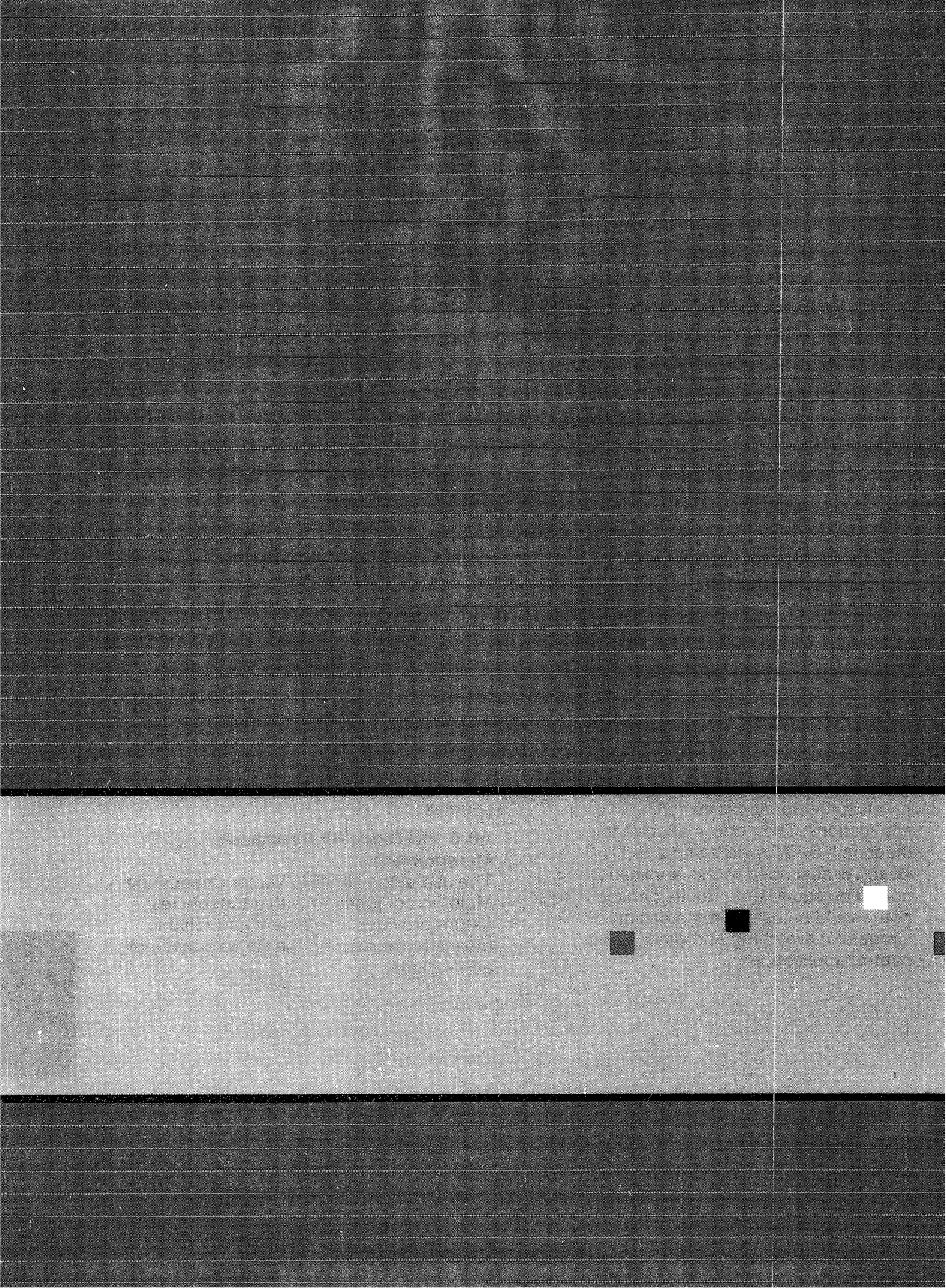
985 Achieve High Isolation in Series Applications with the Low Capacitance HPND-4005 Beam Lead PIN
Low capacitance is required for a diode to achieve high isolation in the series configuration. On the other hand, low resistance is needed for low insertion loss. This combination of characteristics in the HPND-4005 Beam Lead PIN diode makes it well suited for series switching applications. The performance of this diode in a SPST switch and a SPDT switch is described in this application note. The equivalent circuits derived in this note would be useful in the design of circuits for switching and other signal control applications.

992 Beam Lead Attachment Methods
This application bulletin gives a general description of various methods of attaching beam lead components to both hard and soft substrates. A table summarizes most common attachment methods with advantages, disadvantages, and equipment costs.

993 Beam Lead Diode Bonding to Soft Substrate
The hard gold surface on standard PC boards with soft substrate material makes it almost impossible to successfully bond beam lead diodes on to the boards with normally recommended thermocompression bonding. Described in this application note is a new method of resistive spot welding or modified gap welding, which uses a single electrode to weld the beam while the conductor is contracted separately. This method allows light pressure to be used on the weld probe, resulting in an effective bond without damaging the beam lead device.

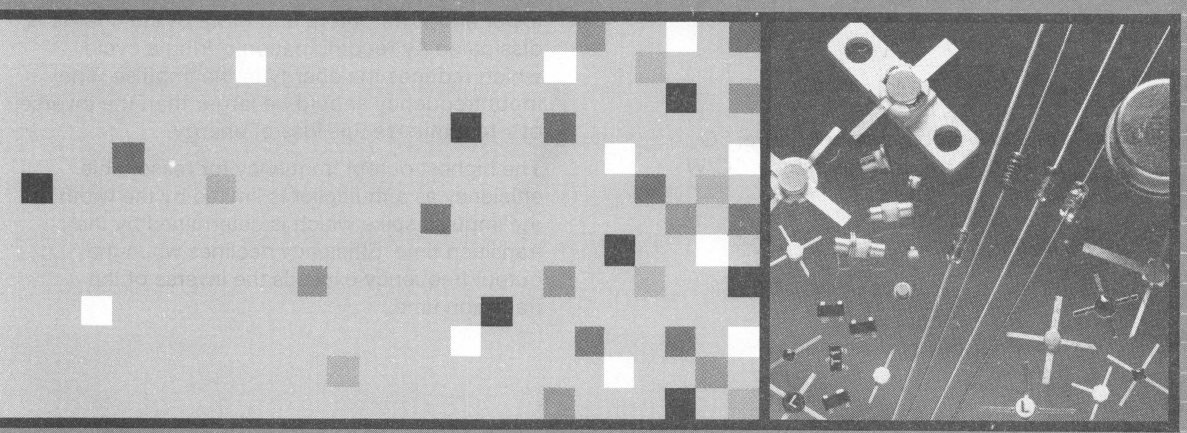
AB 5 Current Source for Diode Testing
This application bulletin describes a constant current source designed primarily for the ease of use in laboratory measurements. Easily programmable by thumb wheel switches in 10 μA steps from 10 μA to 700 mA, its accuracy exceeds most commercially available current sources.

AB 6 PIN Diode RF Resistance Measurement
The use of the HP 4815 Vector Impedance Meter in conjunction with a tunable test fixture provides an efficient and reliable means for measuring the RF resistance of a PIN diode.



Step Recovery Diodes

- Characteristics 7-2
- Applications 7-3
- Selection Guide 7-4
- Alphanumeric Index 7-5
- Chips 7-6
- Packaged Devices 7-8
- Reliability Data 7-14



CHARACTERISTICS OF STEP RECOVERY DIODES

The Step Recovery diode is most graphically described as a charge-controlled switch. That is, a forward bias stores charge, a reverse bias depletes this stored charge, and when fully depleted the SRD ceases to conduct current. The action of turning off, or ceasing current conduction, takes place so fast that the diode can be used to produce an impulse. If this is done cyclically, a train of impulses is produced. A periodic series of impulses in the time domain converts to a series of frequencies (all multiples of the basic exciting frequency) in the frequency domain. If these impulses are used to excite a resonant circuit, much of the total power in the spectrum can be concentrated into a single frequency. Thus input power at one frequency can be converted to output power at a higher frequency.

Two specifications that limit the total power output in any given multiplier mode are maximum junction temperature and thermal resistance. Within this limit, the output for a given input is determined by the efficiency of conversion. Efficiency depends heavily on the design of the multiplier, so Hewlett-Packard does not specify it.

The above specifications are related as follows:

1. Maximum Power Dissipation, P_D (power dissipated by the diode)

$$P_D = \frac{200°C - T_A}{\Theta_{JC}}$$

where T_A = ambient temperature, °C
Θ_{JC} = thermal resistance, °C/W

2. Efficiency, $\eta = \frac{P_O}{P_O + P_D} \cdot 100\%$

where P_O = output power
P_D = power dissipation

The reverse voltage breakdown limit, V_{BR}, limits the pulse height and can limit the input power before the thermal limit is reached.

The low frequency limit of the exciting signal is set by minority carrier lifetime, τ, and the ability to form an effective impulse at the higher frequencies is determined by the transition time, t_t. Under forward current flow, I_F, charge is built up in the SRD. Once reverse biased, reverse current will flow for a short period of time. This is called the delay time, t_d, as in the PIN diode. When all of the carriers have been removed, the current drops abruptly to zero. The time required for the reverse current to go from 0.8 I_R to 0.2 I_R is called transition time. Typical transition times range from 360 psec. down to 60 psec. for Step Recovery diodes.

The delay time t_d is related to minority carrier life time τ by

$$\frac{t_d}{\tau} = \ln\left(1 + \frac{I_F}{I_R}\right).$$

Lifetime is measured by setting $I_F = 1.7\ I_R$ so that $t_D = \tau$.

Minority carrier lifetime sets the lower input frequency limit because as the frequency gets lower and lower, more and more of the charge is dissipated by recombination during a cycle which reduces the energy in the impulse. The input frequency should be larger than the inverse of τ to minimize this loss of energy.

The highest output frequency for reasonable efficiency as a multiplier is limited by the width of the impulse spike which is determined by the transition time. Efficiency declines when the output frequency exceeds the inverse of the transition time.

APPLICATIONS OF STEP RECOVERY DIODES

As brought out in the previous section, the Step Recovery diode can be made to produce very sharp and narrow pulses. These contain harmonics of the exciting frequency.

A circuit which exploits the Step Recovery diode's production of a multitude of frequency components is called a Comb Generator. Comb generators are used in measurement equipment such as Spectrum Analyzers to produce locking signals.

Another type of circuit picks out a single harmonic and optimizes the power output around that harmonic. This circuit is called a Multiplier. The end result of a multiplier is output power at some multiple (2f, 3f, etc.) of the input frequency. The efficiency of the conversion is high enough to make this a very practical scheme for multiplying up from a readily available low frequency oscillator to get a higher frequency signal. Multipliers are used as local oscillators, low power transmitters, or transmitter drivers in radar, telemetry, telecommunications, and instrumentation.

The Microwave Semiconductor Division Field Sales Representative is supported by an applications staff. These technical specialists investigate circuit applications of most interest to the users of these semiconductor devices. The result of these investigations are reported in application notes. Below is a brief summary of Application Notes for Step Recovery Diodes. All of these are available from your local HP Sales Office or nearest HP Components Authorized Distributor or Representative.

928 Ku-Band Step Recovery Multipliers
Discusses the use of step-recovery diodes in a times-eight single-stage frequency multiplier which, at 16 GHz, has a typical maximum output of 75 mW. The note also provides design modifications, together with references, for meeting other performance requirements.

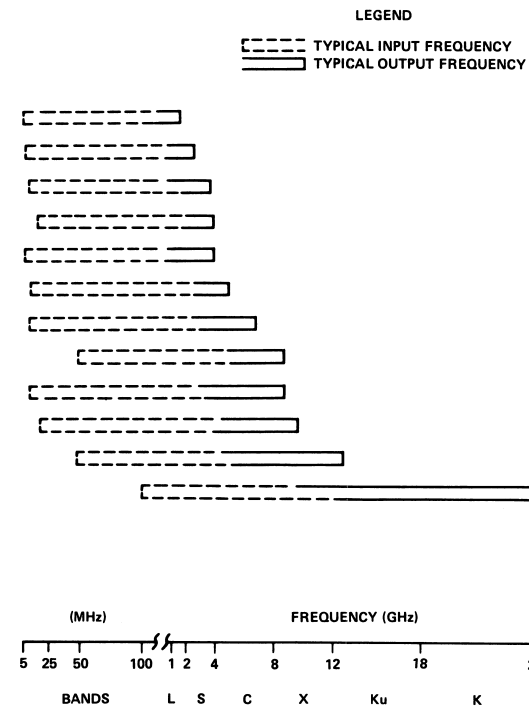
983 Comb Generator Simplifies Multiplier Design
A filter is added to a comb generator to produce high output power over a narrow band of frequencies. Real are presented for a 1 GHz input comb generator with Band output.

984 How to Get More Output Power from a Comb Generator with the Right Bias Resistance
Power output is a comb generator can be doubled by using an appropriate bias resistor. With a half watt input level near 1 GHz, the optimum resistance is about 200 ohms. Higher values of resistance would be needed for higher input frequencies or lower input power.

989 Step Recovery Diode Multiplier
A straightforward technique for multiplier design is presented. The input circuit is alow pass filter which allows all of the input power to be absorbed by the diode and reflects harmonic power back to the diode. The output circuit is a bandpass filter which offers a low loss path to the desired frequency while reflecting all other harmonics back to the diode. The technique is illustrated by a doubler to 4 GHz using Hewlett-Packard 5082-0805 step recovery diode.

STEP RECOVERY DIODE SELECTION GUIDE

Part Number (5082-)		
Chip	**Glass Package**	**Ceramic Package**
0017	—	0300
0032	0180	0241
—	0113, 0114	—
0015	0112	0132
—	0803	0800
—	0815	0805
0021	—	0310
0018	0151, 0153	0253
—	—	0810
0090	0825	0820, 0821
0020	0833	0830, 0320
0008	0840	0335, 0830, 0885
page 7-6	page 7-8	page 7-11



STEP RECOVERY DIODE ALPHANUMERIC INDEX

Part No.	Description	Page Number		
		Chip	Commercial Data Sheet	Reliability Data Sheet
5082-0008	Step Recovery Diode Chip		7-6	7-15
5082-0015	Step Recovery Diode Chip		7-6	7-15
5082-0017	Step Recovery Diode Chip		7-6	7-15
5082-0018	Step Recovery Diode Chip		7-6	7-15
5082-0020	Step Recovery Diode Chip		7-6	7-15
5082-0021	Step Recovery Diode Chip		7-6	7-15
5082-0032	Step Recovery Diode Chip		7-6	7-15
5082-0090	Step Recovery Diode Chip		7-6	7-15
5082-0112	Step Recovery Diode	5082-0015	7-8	7-15
5082-0113	Step Recovery Diode		7-8	7-15
5082-0114	Step Recovery Diode		7-8	7-15
5082-0132	Step Recovery Diode	5082-0015	7-8	7-15
5082-0151	Step Recovery Diode	5082-0018	7-8	7-15
5082-0153	Step Recovery Diode	5082-0018	7-8	7-15
5082-0180	Step Recovery Diode	5082-0032	7-8	7-15
5082-0241	Step Recovery Diode	5082-0032	7-11	7-15
5082-0243	Step Recovery Diode		7-11	7-15
5082-0253	Step Recovery Diode	5082-0018	7-11	7-15
5082-0300	Step Recovery Diode	5082-0017	7-11	7-15
5082-0310	Step Recovery Diode	5082-0021	7-11	7-15
5082-0320	Step Recovery Diode	5082-0020	7-11	7-15
5082-0335	Step Recovery Diode	5082-0008	7-11	7-15
5082-0800	Step Recovery Diode		7-11	7-15
5082-0803	Step Recovery Diode		7-8	7-15
5082-0805	Step Recovery Diode		7-11	7-15
5082-0810	Step Recovery Diode		7-11	7-15
5082-0815	Step Recovery Diode		7-11	7-15
5082-0820	Step Recovery Diode	5082-0090	7-11	7-15
5082-0821	Step Recovery Diode	5082-0090	7-11	7-15
5082-0825	Step Recovery Diode	5082-0090	7-8	7-15
5082-0830	Step Recovery Diode	5082-0020	7-11	7-15
5082-0833	Step Recovery Diode	5082-0020	7-8	7-15
5082-0835	Step Recovery Diode	5082-0008	7-11	7-15
5082-0840	Step Recovery Diode	5082-0008	7-8	7-15
5082-0885	Step Recovery Diode	5082-0008	7-11	7-15

HEWLETT PACKARD

STEP RECOVERY DIODE CHIPS

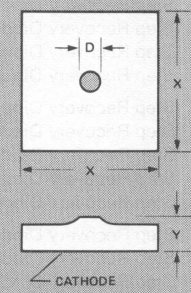
5082-0008
5082-0015
5082-0017
5082-0018
5082-0020
5082-0021
5082-0032
5082-0090

Features

OPTIMIZED FOR BOTH LOW AND HIGH ORDER MULTIPLIER DESIGNS FROM UHF THROUGH Ku BAND

PASSIVATED CHIP FOR MAXIMUM STABILITY AND RELIABILITY

GOLD TOP CONTACT FOR LONG SHELF LIFE AND BONDABILITY



Outline 01

Dimension	5082-							
	0020	0008	0015	0017	0018	0021	0032	0090
D	0.13 (5)	0.06 (2.5)	0.15 (6)	0.39 (15.5)	0.05 (2)	0.22 (8.5)	0.32 (12.5)	0.15 (6)
X	0.38 (15)	0.38 (15)	0.38 (15)	0.64 (25)	0.38 (15)	0.51 (20)	0.51 (20)	0.38 (15)
Y	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)	0.11 (4.5)

DIMENSIONS IN MILLIMETERS (1/1000 inch)

Description

These diodes are manufactured using modern epitaxial growth techniques. The diodes are passivated with a thermal oxide for maximum stability. The result is a family of devices offering highly repeatable, efficient and reliable performance. Both the anode and cathode contact metalizations are gold allowing long shelf life and repeatable bondability. These diodes are designed to meet the general requirements of MIL-S-19500.

Maximum Ratings

Junction Operating and
Storage Temperature Range ..... −60° C to +200° C
Maximum Die Attach
Temperature ..... +310° C for 1 minute

Applications

These Step Recovery Diodes are intended for medium and low power multipliers. Typical applications are in hybrid local oscillators, especially where low phase noise is required, in terrestrial communications, satellite communications, TVRO, mobile communications and test equipment Input frequencies extend down to 10 MHz with output frequencies through 40 GHz.

Electrical Specifications at $T_A = 25°C$

Part Number	Minimum Breakdown Voltage V_{BR}(V)[1]	Typical Chip Capacitance C_j (pF)[2]	Typical Lifetime τ (ns)[3]	Typical Transition Time		Nearest Equivalent Packaged Part No. 5082-
				Transition Time t_t (ps)	Charge Level (pc)	
5082-0008	15	0.38	10	60	100	0835
5082-0015	35	1.2	60	150	1000	0132
5082-0017	75	4.0	300	300	2400	0300
5082-0018	25	0.5	20	70	200	0253
5082-0020	25	0.7	20	60	300	0830
5082-0021	40	2.0	100	150	1000	0310
5082-0032	65	4.0	150	250	1500	0241
5082-0090	45	1.0	50	80	300	0820

Notes:

1. Minimum Breakdown Voltage test condition is $I_R = 10\ \mu A$.
2. Capacitance sample test condition is $V_R = 10$ V and f = 1 MHz.
3. Lifetime sample test condition is $I_F = 10$ mA and $I_R = 6$ mA.

HEWLETT PACKARD

GLASS PACKAGED STEP RECOVERY DIODES

5082-0112 5082-0803
5082-0113 5082-0815
5082-0114 5082-0825
5082-0151 5082-0833
5082-0153 5082-0840
5082-0180

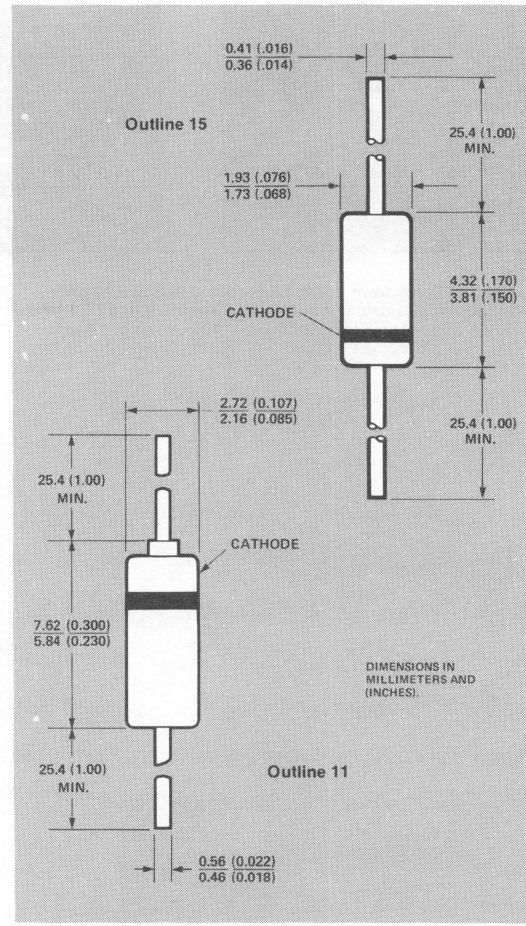
Features

OPTIMIZED FOR BOTH LOW AND HIGH ORDER

MULTIPLIER DESIGNS FROM UHF THROUGH Ku BAND

PASSIVATED CHIP FOR MAXIMUM STABILITY AND RELIABILITY

AVAILABLE IN A VARIETY OF PACKAGES



Description/Applications

These diodes are manufactured using modern epitaxial growth techniques. The diodes are passivated with a thermal oxide for maximum stability. The result is a family of devices offering highly repeatable, efficient and reliable performance which are designed to meet the general requirements of MIL-S-19500.

These diodes are intended for medium and low power multipliers. Typical applications are in local oscillators, especially where low phase noise is required, in terrestrial communications, satellite communications, TVRO, mobile communications and test equipment. Input frequencies extend down to 10 MHz with output frequencies reaching 26 GHz.

Mechanical Specifications

The HP Outline 15 package has a glass hermetic seal with plated Dumet leads which should be restricted so that the bend starts at least 1/16 inch (1.6 mm) from the glass body. With this restriction, it will meet MIL-STD-750, Method 2036, Conditions A and E (4 lb. [1.8 kg] tension for 30 minutes). The maximum soldering temperature is 230° C for five seconds. Marking is by digital coding with a cathode band. Typical package inductance is 1.8 nH.

The HP Outline 11 package has a glass hermetic seal with Dumet leads. The package will meet MIL-STD-750, Method 2036, Condition A (2 lbs. tension for 15 sec.) and E. The maximum soldering temperature is 230° C for five seconds. Outline 11 package capacitance and inductance are typically 0.15 pF and 4 nH, respectively.

Maximum Ratings

Junction Operating and Storage Temperature . . . . . -65°C to 200°C

DC Power Dissipation at $T_{CASE} = 25°C$ . . . . $\frac{200°C - T_{case}}{\theta_{jc}}$

Soldering Temperature . . . . . 230°C for 5 sec.

Electrical Specifications at $T_A = 25°C$

Part Number	Maximum Junction Capacitance C_J (pF)	Minimum Breakdown Voltage V_{BR} (V)	Minimum Cutoff Frequency f_C (GHz)	Transition Time[1]		Minimum Lifetime τ (nsec)	Package Outline
				Maximum t_t (psec)	Charge Level (pc)		
5082-0840	0.60*	15	300	75	100	10	15
5082-0833	1.6*	25	175	90	300	10	15
5082-0153	0.40	25	—	95	200	10	15
5082-0151	0.65	15	—	100	200	10	15
5082-0825	2.0*	45	160	160	300	30	15
5082-0112	1.55	35	—	175	1000	50	11
5082-0180	4.45	50	—	225	1500	100	11
5082-0114	3.85	35	—	225	1500	80	11
5082-0113	4.85	35	—	250	1500	80	11
5082-0815	4.0*	50	140	320	1500	100	15
5082-0803	6.0*	70	100	400	1500	200	15
Test Conditions	f = 1 MHz V_R = 10 V *V_R = 6 V	I_R = 10 μA	$f_C = \frac{1}{2\pi R_S C_j}$			I_F = 10 mA I_R = 6 mA	

Notes:
1. The transition times shown for the package 15 devices are limited by the package inductance to a minimum of 100 ps. The lower transition times shown for the -0833, -0840, -0151, and -0153 are based on the performance of the chip.
2. Typical Θ_{JC} for Outline 15 is 600° C/W and for Outline 11 is 300° C/W.

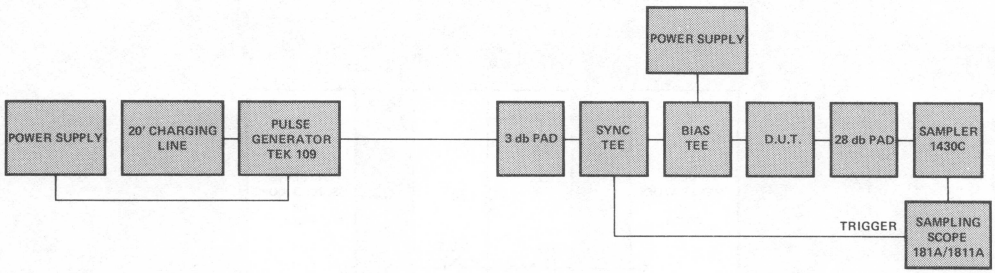


Figure 1. Test circuit for transition time. The pulse generator circuit is adjusted for a 0.5 A pulse when testing 5082-0151 and -0840. A pulse of 1.0A is used for all other diodes. The bias current is adjusted for the specified stored charge level. The transition time is read between the 20% and the 80% points on the oscilloscope.

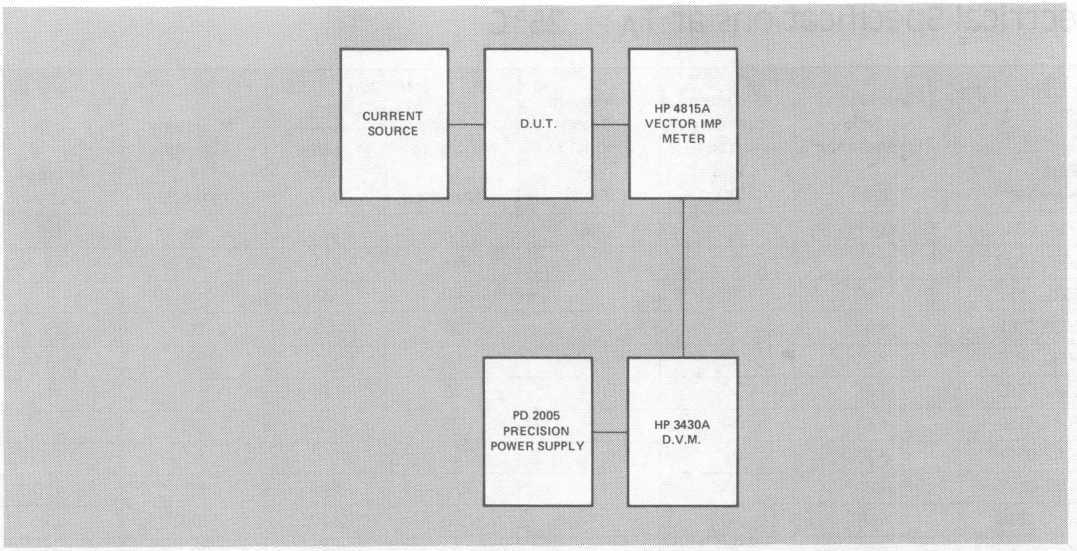


Figure 2. Test set-up for measurement of series resistance. The D.U.T. is forward biased (I_F) and the real part of the diode impedance is measured at 100 MHz. The D.V.M. is set up to read the real part on the Vector voltmeter. The precision power supply is used to offset the test circuit resistance. R_S is measured at I_F = 100 mA except 5082-0803 where I_F = 500 mA.

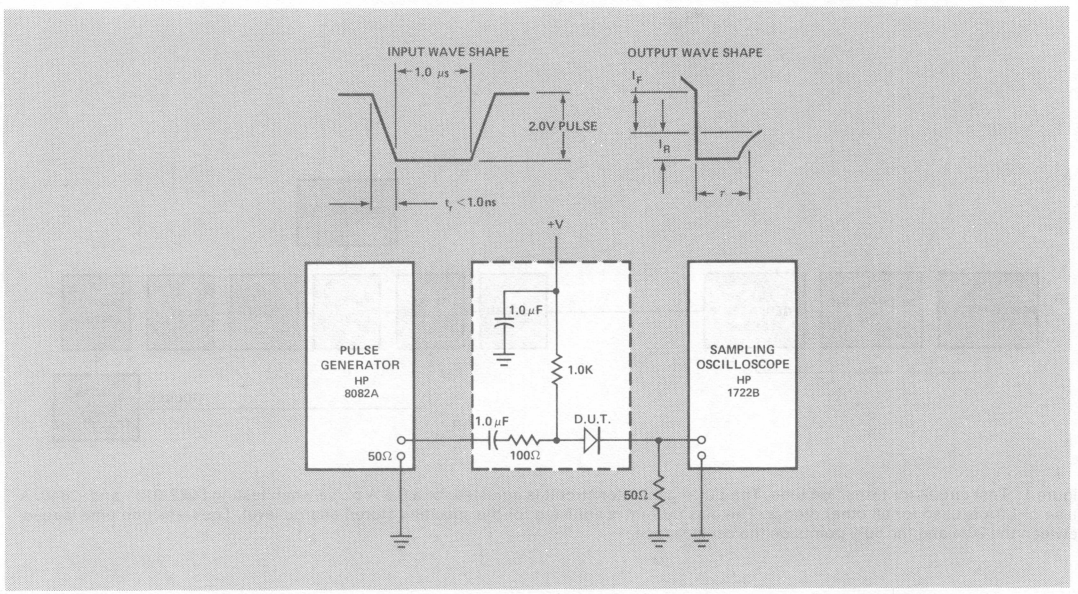


Figure 3. The circuit for measurement of the effective minority carrier lifetime. The value of the reverse current (I_R) is approximately 6 mA and the forward current (I_F) is 10 mA. The lifetime (τ) is measured across the 50% points of the observed wave shape. The input pulse is provided by a pulse generator having a rise time of less than one nanosecond. The output pulse is amplified and observed on a sampling oscilloscope.

HEWLETT PACKARD

CERAMIC PACKAGED STEP RECOVERY DIODES

5082-0132	5082-0800
5082-0241	5082-0805
5082-0243	5082-0810
5082-0253	5082-0820
5082-0300	5082-0821
5082-0310	5082-0830
5082-0320	5082-0835
5082-0335	5082-0885

Features

UHF THROUGH Ku BAND DIODES
For Low Order and High Order Multipliers

RF TESTED
For Guaranteed Performance (5082-0300 Series)

HERMETIC PACKAGE
For Industrial/Military Environments

Description/Applications

HP Step Recovery Diodes are constructed using modern epitaxial techniques. Oxide passivation insures maximum stability and reliability. Devices are available in many package styles.

These devices are intended for use as low and high order harmonic generators requiring the ultimate in performance and reliability. They excel as doublers as well as high order multipliers, because the fast transition time design allows full usage of the forward stored charge effect in improving nonlinearity and efficiency for frequency multiplication. These step recovery diodes have the basic design capability to meet the general reliability requirements of MIL-S-19500, in addition to the special reliability requirements of man-rated space systems.

Maximum Ratings

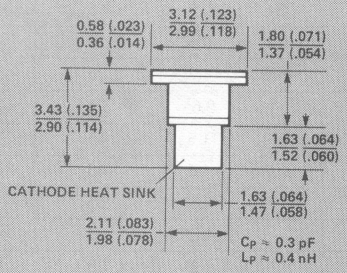
Junction Operating and Storage Temperature ..... −65° C to 200° C

DC Power Dissipation at $T_{CASE} = 25°C$ ..... $\frac{200°C - T_{CASE}}{\theta_{jc}}$

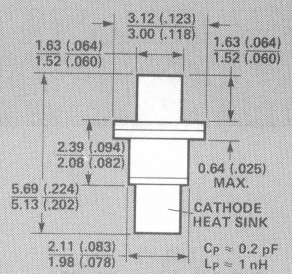
Soldering Temperature ..... 230° C for 5 sec.

Mechanical Specifications

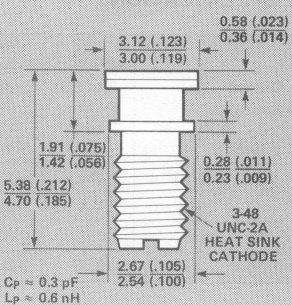
Hewlett-Packard's Step Recovery Diodes are available in a variety of packages. The metal ceramic packages are hermetically sealed. The anode studs and flanges are gold-plated Kovar. The cathode studs are gold-plated copper. The maximum soldering temperature for metal-ceramic packages is 230° C for 5 seconds.



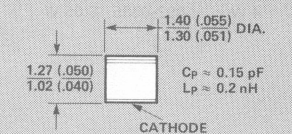
Outline 41



Outline 31



Outline 40



Outline 56

DIMENSIONS IN MILLIMETERS AND (INCHES)

Electrical Specifications at $T_A = 25°C$

Part Number	Junction Capacitance C_J (pF) Min.	Junction Capacitance C_J (pF) Max.	Minimum Breakdown Voltage V_{BR} (V)	Minimum Cutoff Frequency f_C (GHz)	Package Outline	Transition Time Maximum t_t (psec)	Transition Time Charge Level (pC)	Minimum Lifetime τ (nsec)	Typical Thermal Resistance θ_{jc} (°C/W)	Typical Output Power P_O (W)
5082-0835	0.1	0.5	15	350	31	75	100	10	60	0.3
5082-0885	0.1	0.5	15	350	56	75	100	10	60	0.3
5082-0830	0.35	1.2	25	200	31	100	300	10	45	1.0
5082-0253	—	0.6*	25	—	31	100	200	10	75	—
5082-0820	0.7	1.5	45	160	31	160	300	30	30	2.5
5082-0821	0.7	1.5	45	160	41	160	300	30	30	2.5
5082-0132	—	1.5*	35	—	31	175	1000	50	40	—
5082-0241	—	4.6*	65	—	31	200	1500	100	20	—
5082-0243	—	1.2*	35	—	31	200	600	40	50	—
5082-0810	1.5	2.5	60	140	31	260	1000	80	25	4
5082-0805	2.5	3.5	60	140	31	320	1500	100	20	6
5082-0800	3.5	5.0	75	100	40	400	1500	200	15	10
Test Conditions	f = 1 MHz V_R = 6 V *V_R = 10 V		$I_R = 10\ \mu A$	$f_C = \frac{1}{2\pi R_S C_j}$				I_F = 10 mA I_R = 6 mA		As a doubler

RF Tested Diodes at $T_A = 25°C$

ELECTRICAL SPECIFICATIONS

Part Number 5082-	Output Frequency, f_o (GHz)	N Order	Minimum Output Power, P_o[1] (W)	Junction Capacitance at -10 V, C_j (pF) Min.	Junction Capacitance at -10 V, C_j (pF) Max.	Breakdown Voltage at $I_R = 10\ \mu A$ V_{BR} (V) Min.	Breakdown Voltage at $I_R = 10\ \mu A$ V_{BR} (V) Max.	Maximum Thermal Resistance, θ_{jc} (°C/W)	Package Outline	Typical Transition Time t_t (ps)	Typical Transition Time Charge Level (pc)	Typical Lifetime τ (ns)
0300	2	X 10	2.0	3.2	4.7	75	100	14	40	300	2400	200
0310	6	X 10	0.4	1.6	2.7	40	80	30	41	160	1000	75
0320	10	X 5	0.23	0.35	1.0	25	40	60	41	75	300	25
0335	16	X 8	0.03	0.25	0.5	20	30	75	31	60	100	15

Note:
1. Guaranteed multiplier tested results. Input power is:
   5082-0300 15 W 5082-0320 2 W
   5082-0310 4 W 5082-0335 0.65 W

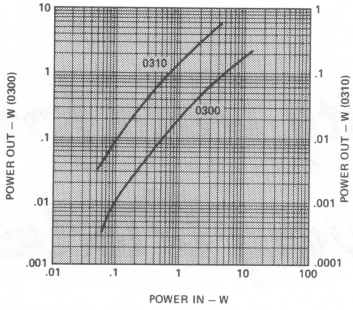


Figure 1. Typical Output Powers vs. Input Power at $T_A = 25°C$. The 5082-0300 is measured in a x 10 multiplier with P_{IN} at 0.2 GHz and P_O at 2.0 GHz. The 5082-0310 is measured in a x 10 multiplier with P_{IN} at 0.6 GHz and P_O at 6.0 GHz.

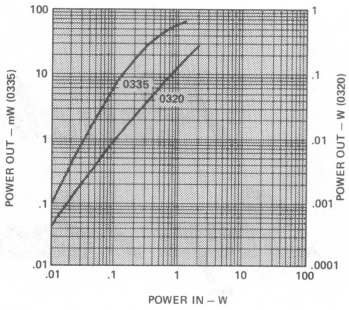


Figure 2. Typical Output Power vs. Input Power at $T_A = 25°C$. The 5082-0335 is measured in a x 8 multiplier with P_{IN} at 2 GHz and P_O at 16 GHz. The 5082-0320 is measured in a x 5 multiplier with P_{IN} at 2.0 GHz and P_O at 10 GHz.

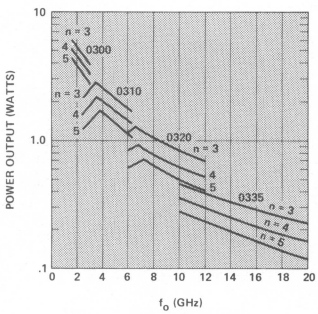


Figure 3. Predicted power output curves for 03XX step recovery diodes in X3, X4, and X5 multiplier applications. These results were obtained using computer optimization programs.

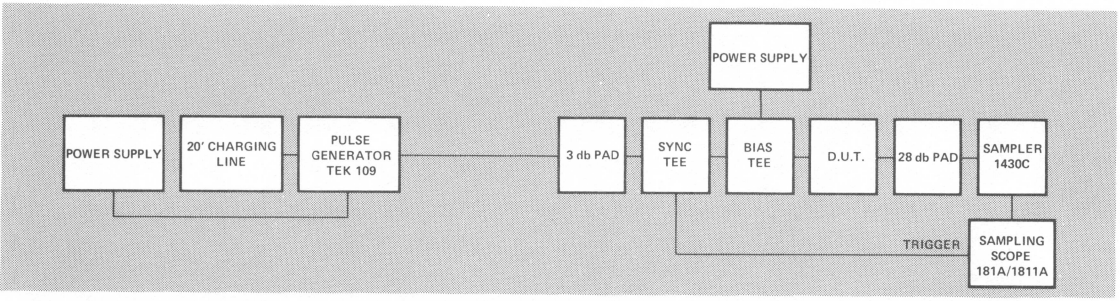


Figure 4. Test circuit for transition time. The pulse generator circuit is adjusted for a 0.5 A pulse when testing 5082-0253, -0335, -0835, and -0885. A pulse of 1.0 A is used for all other diodes. The bias current is adjusted for the specified stored charge level. The transition time is read between the 20% and the 80% points on the oscilloscope.

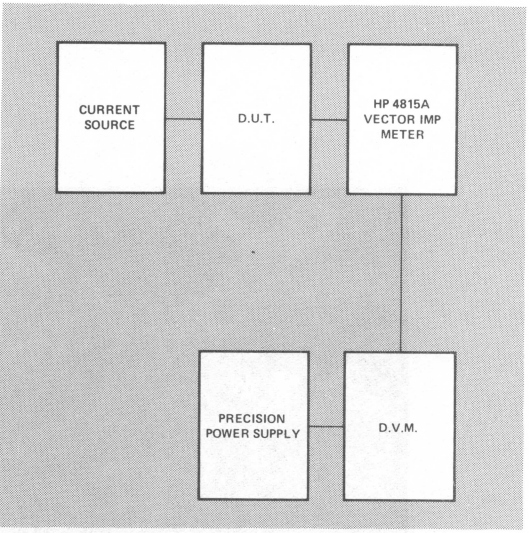


Figure 5. Test set-up for measurement of series resistance. The D.U.T. is forward biased (I_F) and the real part of the diode impedance is measured at 100 MHz. The D.V.M. is set up to read the real part on the Vector Voltmeter. The precision power supply is used to offset the test circuit resistance. R_S is measured at I_F = 100 mA, except -0800 where I_F = 500 mA and -0885 where I_F = 300 mA.

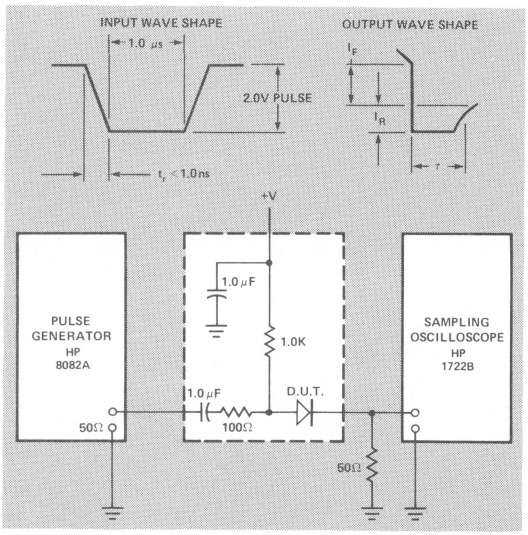
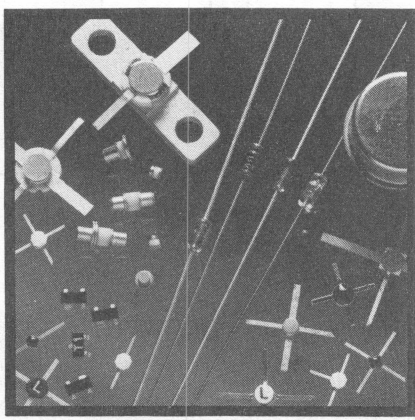


Figure 6. The circuit for measurement of the effective minority carrier lifetime. The value of the reverse current (I_R) is approximately 6 mA and the forward current (I_F) is 10 mA. The lifetime (τ) is measured across the 50% points of the observed wave shape. The input pulse is provided by a pulse generator having a rise time of less than one nanosecond. The output pulse is amplified and observed on a sampling oscilloscope.

Reliability Data for Step Recovery Diodes

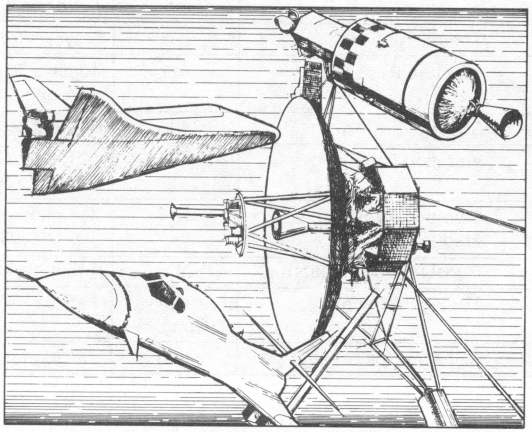


HEWLETT PACKARD

RELIABILITY DATA
STEP RECOVERY DIODES

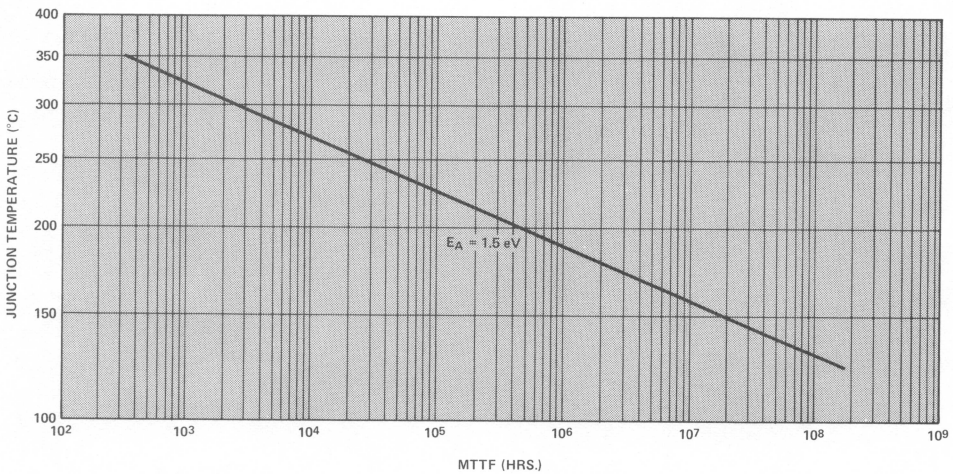
Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is initially compiled from reliability tests run prior to market introduction to demonstrate that a product meets design criteria. Additional tests are run periodically. The data on this sheet represents the latest review of accumulated test results.



Applications

This information represents the capabilities of the generic device. Failure rates and MTTF values presented here are achievable with normal MIL-S-19500 TX level screening. Reliability can only be guaranteed by testing specified lots of devices, under specified conditions, with specified LTPD levels.



Mean Time To Failure vs. Junction Temperature

Burn-In and Storage

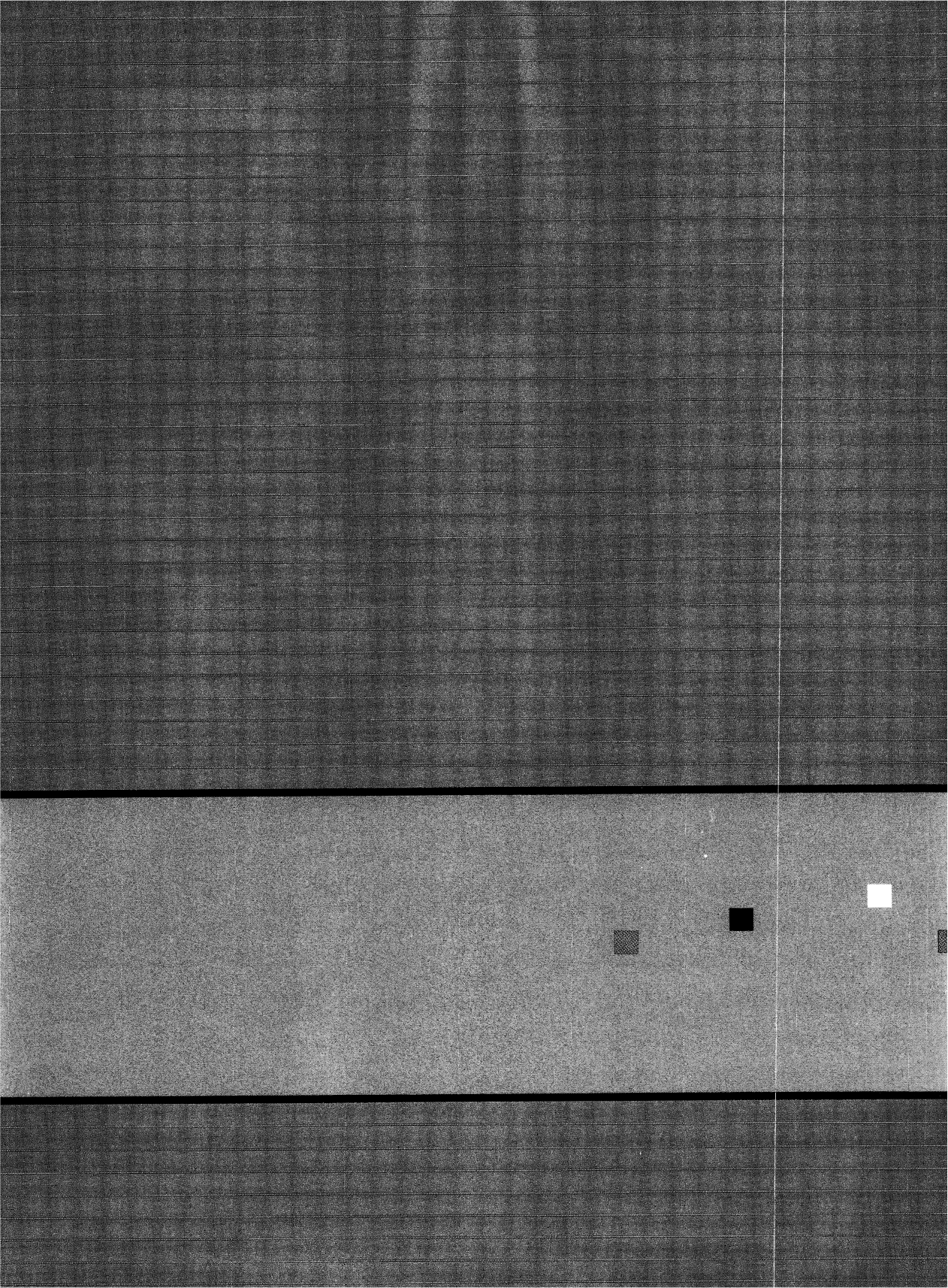
Preconditioning and screening tests are recommended for devices terminating in high reliability equipments. The following results were obtained with preconditioning and screening.

Test	Test Conditions	LTPD/1000 Hours
High Temperature Life	1,000 hrs. min. storage time at 150° C	2
Steady State Operating Life	1,000 hrs. min. operating time, P_{FM} = 175 mW V_{RM} = 12 V, f = 60 Hz, T_A = 25° C	3

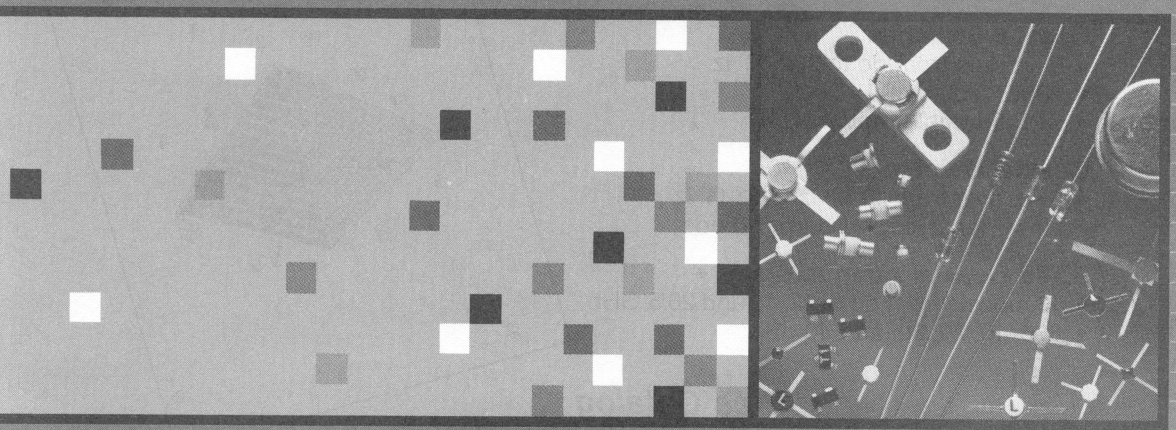
Environmental

The following cumulative test results have been obtained from reliability testing performed at HP Components Division, in accordance with the latest revisions of Military Semiconductor Specifications MIL-STD-19500, MIL-STD-202 and MIL-STD-750.

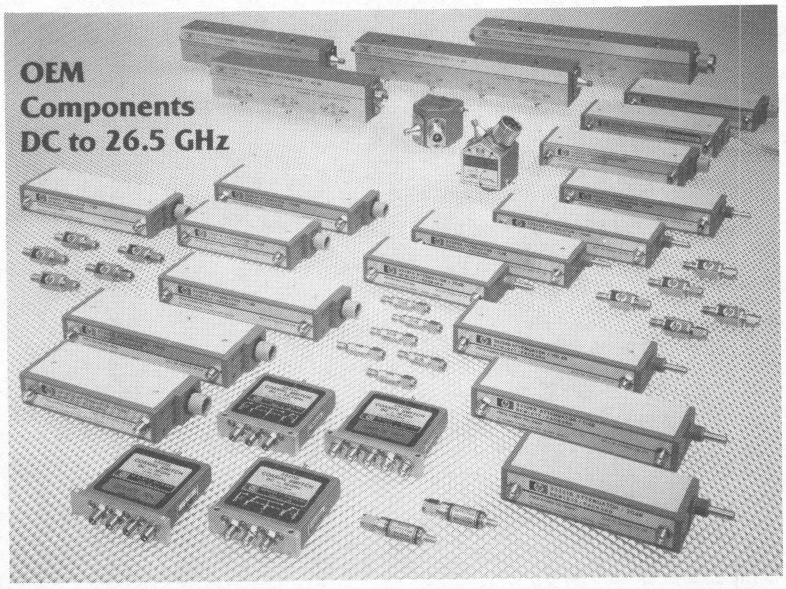
Test	MIL-STD-750 Reference	Test Conditions	LTPD
Temperature Cycling	1051 Cond. B	5 cycles from −65° C to +150° C, .5 hours at extremes, 5 min. transfer	5
Thermal Shock	1056	5 cycles from 0° C to +100° C, 3 sec. transfer	5
Moisture Resistance	1021	10 days, 90-98% RH, −10 to +65° C, non-operating	8
Shock	2016	5 blows each X_1, Y_1, Y_2, 1500 G. 0.5 msec pulse	10
Vibration Fatigue	2046	32 ± 8 hrs. each X, Y, Z, 96 hr. total, 60 Hz, 20 G min.	10
Vibration Variable Frequency	2056	4, 4 minute cycles each X, Y, Z, at 20 G min. 100 to 2000 Hz	10
Constant Acceleration	2006	1 minute each X_1, Y_1, Y_2, at 20,000 G	10
Terminal Strength	2037 Cond. F	Pkg. 32 — 2 lbs. for 3 sec, 120° apart	20
Salt Atmosphere	1041	35° fog for 24 hours	20



Coaxial and Waveguide Components



PRECISION COMPONENTS FOR HIGH-PERFORMANCE SYSTEM DESIGNS

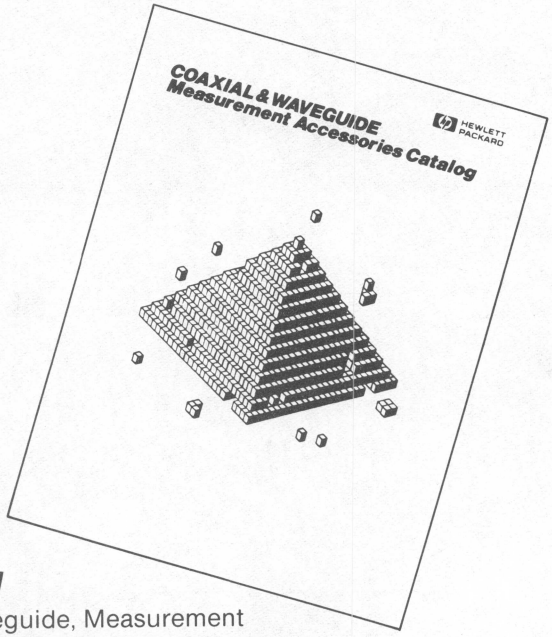


Manual and Programmable Coaxial Step Attenuators
- 15 models from dc to 4, 18 and 26.5 GHz
- 5 million step reliability
- 0 to 11 dB in 1 dB steps
- 0 to 70, 90 and 110 dB in 10 dB steps

Coaxial Switches
- 8 models from dc to 26.5 GHz
- 90 dB isolation
- SPDT, transfer and matrix

Coaxial Detectors
- 3 models from 10 MHz to 33 GHz
- New Planar-doped-barrier diode

Fixed Coaxial Attenuators
- 16 models from dc to 12, 18 and 26.5 GHz
- 3, 6, 10, 20, 30, and 40 dB

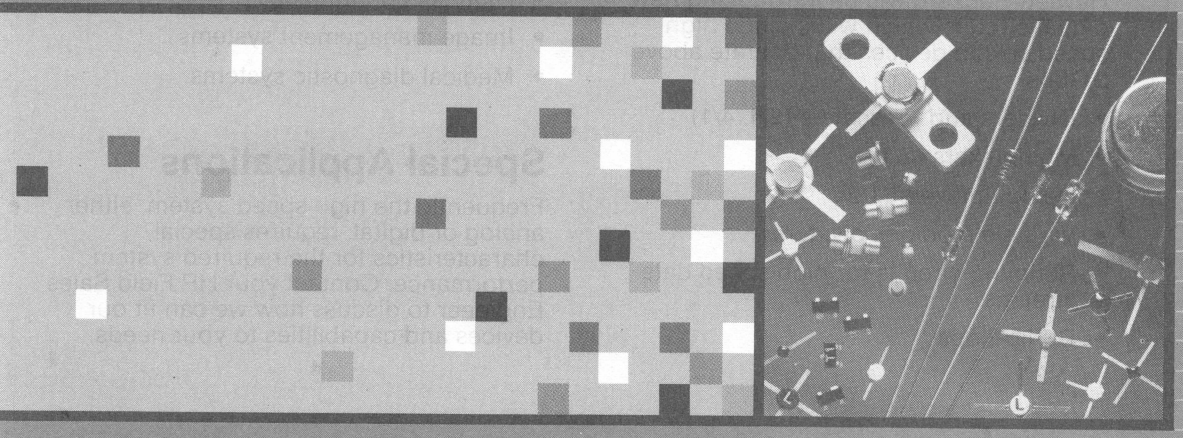


Free Catalog

Coaxial and Waveguide, Measurement Accessories, Performance data and specifications on over 400 components. Ask your local HP Sales Office for your free catalog (Lit# 5954-6401).

Amplifiers and High Speed Digital Circuits

- High Speed Digital Circuits 9-2
- Amplifiers 9-4
- Abstracts of Application Notes 9-29



HIGH SPEED CIRCUITS

This section contains the new High Speed Circuits from HP for both Analog and Digital applications. They are especially useful for applications above 500 MHz or 500 Mbps. Most of these devices provide excellent performance through 2 to 3 GHz.

This product family contains both monolithic integrated circuits and hybrid circuits using Hewlett-Packard's semiconductor technologies for advanced bipolar silicon ICs (Ft>12 GHz), discrete transistors and PIN diodes. Many of the products are in the new high speed circuit surface mount package recently developed by HP. This combines superior performance with the technical and economic benefits of surface mounting for both analog and digital circuits.

Circuit Types

ANALOG

- Broadband amplifiers with exceptional phase linearity and gain flatness
- Variable gain amplifiers with excellent phase and gain stability and very fast response times to level change requirements (AGC)
- Low noise amplifiers for broadband or narrowband operation
- New analog products will include:

  Down converters

  High P_{1dB} amplifiers

  Narrowband amplifiers

DIGITAL

Hewlett-Packard will be introducing new digital circuits which will include high speed silicon devices that operate above 2 Gbps.

- Dividers and Prescalers (2/1, 4/1)
- Multiplexers (2/1)
- Demultiplexers (1/2)
- Variable modulus dividers
- Retiming circuits for high speed data streams
- D Flip-flops

PACKAGING

These products are offered in both our new High Speed surface mount package in addition to the familiar TO-8 for the analog amplifiers and gain control circuits.

Applications

- High speed fiber optic systems
- Global Positioning Satellite systems
- Radar systems
- ECM/ESM systems
- Communications systems
- Intercomputer communications
- High speed interfaces
- Image management systems
- Medical diagnostic systems

Special Applications

Frequently the high speed system, either analog or digital, requires special characteristics for the required system performance. Contact your HP Field Sales Engineer to discuss how we can fit our devices and capabilities to your needs.

SELECTION GUIDE

Cascadable Amplifiers

Part Number	Pkg.	Flow To FHIGH (MHz)	Max. Gain (dB)	Gain Flat (dB)	NF (dB)	P_{1dB} (dBm)	V_{CC} (V)
HAMP-1001	TO-8	5-2800	7	±1	7	12.5	15
HAMP-1002		5-1900	10		5.5	10.5	
HAMP-1003		5-2100	10		5	6.5	
HAMP-1004		5-1650	14		4	1	
HAMP-3001	HBIC	0.1-1800	22		5.5	10	
HAMP-6001		0.1-1650	14		4	1	
HAMP-6002		0.1-1900	10		5.5	10.5	
HAMP-6003		0.1-2800	7		7	12.5	

Automatic Gain Controllable Amplifiers

Characteristic	HAMP-4001	-4002	-5001
Package	TO-8	TO-8	HBIC
Frequency (MHz)	10-1000	10-1500	0.1-1500
Max. Gain (dB)	22	17	12
Gain Flatness (±dB)	1	1	1
Noise Figure (dB)	5	6	7
Gain Control Range (dB)	27	30	25
P_{1dB} (dBm)	9	9	9
Supply Voltage (V)	15	15	15
Max. AGC Voltage (V)	5	5	5

AMPLIFIERS ALPHANUMERIC INDEX

MODEL NO.	DESCRIPTION	PAGE NO.
HAMP-1001	10-1500 MHz TO Cascadable Amplifier	9-5
HAMP-1001TXV	Hi-Rel HAMP-1001	9-5
HAMP-1002	10-1500 MHz TO-8 Cascadable Amplifier	9-5
HAMP-1002TXV	Hi-Rel HAMP-1002	9-5
HAMP-1003	10-1500 MHz TO-8 Cascadable Amplifier	9-5
HAMP-1003TXV	Hi-Rel HAMP-1003	9-5
HAMP-1004	10-1500 MHz TO-8 Cascadable Amplifier	9-5
HAMP-1004TXV	Hi-Rel HAMP-1004	9-5
HAMP-4001	Variable Gain Wideband Amplifier	9-18
HAMP-4001TXV	Hi-Rel HAMP-4001	9-18
HAMP-4002	Variable Gain Wideband Amplifier	9-18
HAMP-4002TXV	Hi-Rel HAMP-4002	9-18

BOLD FACE indicates new products

HEWLETT PACKARD

10-1500 MHz TO-8 CASCADABLE AMPLIFIER

HAMP-1001
HAMP-1002
HAMP-1003
HAMP-1004
TXV VERSIONS

Features

WIDE 1 dB BANDWIDTH

EXCEPTIONAL PHASE LINEARITY

LOW VARIATION OVER TEMPERATURE

EASILY CASCADABLE IN A 50 Ω SYSTEM

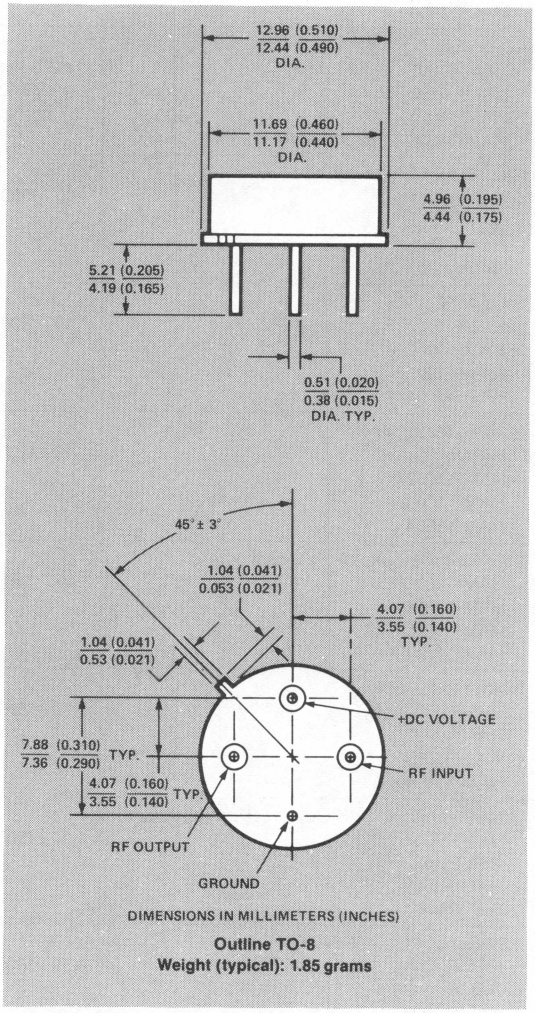
HIGH RELIABILITY VERSIONS AVAILABLE

Description/Applications

The HAMP-1000 amplifier series are thin film hybrids using bipolar transistors. The design uses sensitive feedback which provides exceptional phase linearity and high performance over a wide temperature range and bandwidth. The internal bias network and coupling capacitors eliminate the need for external support circuitry.

The amplifiers are ideal for IF, RF and high speed digital applications.

The HAMP-1000 series amplifiers are supplied in a standard rugged TO-8 hermetic package and are capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-750/883.



Outline TO-8
Weight (typical): 1.85 grams

Absolute Maximum Ratings

DC Voltage ..... 30.0 V
Continuous RF Input Power ..... +15 dBm
Short Term RF Input Power ..... +20 dBm
(CW 10 minute duration)
Maximum Input Peak Power ..... +27 dBm
(3 μsec Pulse, one single pulse)
Operating Case Temperature ..... -55°C to +125°C
Storage Temperature ..... -65°C to +150°C

Operation in excess of any one of these conditions may result in permanent damage to this device.

MTTF (Calculated, MIL-STD-217D): 1.2×10^7 hours at Case Temperature +85°C.

For further technical details, see Application Note 996, "Designing with HAMP-1001, 1002, 1003 and 1004 TO-8 Amplifiers".

Electrical Specifications (Measured in 50Ω System at +15 V)

Parameter	Condition	Units	Typical 25°C	Guaranteed 0°C to 50°C	Guaranteed -55°C to 85°C
f_{LOW}					
HAMP-1001	1 dB Down from Gain @ 100 MHz	MHz	5		
HAMP-1002			5		
HAMP-1003			5		
HAMP-1004			5		
f_{HIGH}					
HAMP-1001	1 dB Down from Gain @ 100 MHz	MHz	2800		
HAMP-1002			1900		
HAMP-1003			2100		
HAMP-1004			1650		
Gain, MAX					
HAMP-1001	10 - 1500 MHz	dB	6.8	7.2	7.3
HAMP-1002			10.2	10.6	10.7
HAMP-1003			10.1	10.5	10.6
HAMP-1004			13.4	14.2	14.5
Gain, MIN					
HAMP-1001	10 - 1500 MHz	dB	6.4	5.9	5.8
HAMP-1002			9.7	9.2	8.4
HAMP-1003			9.7	9.1	9.0
HAMP-1004			12.5	11.8	11.0
Gain Flatness, MAX					
HAMP-1001	10 - 1500 MHz	dB	±0.18	±0.5	±0.6
HAMP-1002			+0.2	+0.5	+0.7
HAMP-1003			+0.15	+0.5	+0.5
HAMP-1004			+0.3	+0.7	+1.3
Maximum Deviation from Linear Phase					
HAMP-1001	100 - 1500 MHz	Degrees	0.5		
HAMP-1002			1.8		
HAMP-1003			1.6		
HAMP-1004			1.7		
Noise Figure, MAX					
HAMP-1001	10 - 1500 MHz	dB	6.7	7.5	8.0
HAMP-1002			5.1	5.7	6.4
HAMP-1003			5.0	5.5	6.0
HAMP-1004			4.0	5.0	5.6
Power Output @ 1 dB Compression (Minimum)					
HAMP-1001	10 - 1500 MHz	dBm	12.5	11.5	10.0
HAMP-1002			10.5	8.8	6.9
HAMP-1003			6.5	3.8	3.0
HAMP-1004			1.0	-1.0	-3.5
VSWR Input/Output, MAX					
HAMP-1001	10 - 1500 MHz		1.7	2.0	2.0
HAMP-1002			1.5	2.0	2.0
HAMP-1003			1.7	2.0	2.0
HAMP-1004			1.7	2.0	2.0
Second Order Harmonic Intercept Point					
HAMP-1001	10 - 1500 MHz	dBm	45.0		
HAMP-1002			31.0		
HAMP-1003			25.0		
HAMP-1004			25.0		

Electrical Specifications (Measured in 50 Ω System at +15 V)

Parameter	Condition	Units	Typical 25°C	Guaranteed 0°C to 50°C	Guaranteed -55°C to 85°C
Second Order Two Tone Intercept Point					
HAMP-1001	10 - 1500 MHz	dBm	40.0		
HAMP-1002			27.0		
HAMP-1003			22.0		
HAMP-1004			20.0		
Third Order Two Tone Intercept Point					
HAMP-1001	10 - 1500 MHz	dBm	22.0		
HAMP-1002			20.0		
HAMP-1003			15.0		
HAMP-1004			12.0		
DC Current					
HAMP-1001	10 - 1500 MHz	mA	63.0		
HAMP-1002			52.0		
HAMP-1003			39.0		
HAMP-1004			18.0		

Typical Performance at V_{CC} = 15 V

GAIN AT THREE TEMPERATURES

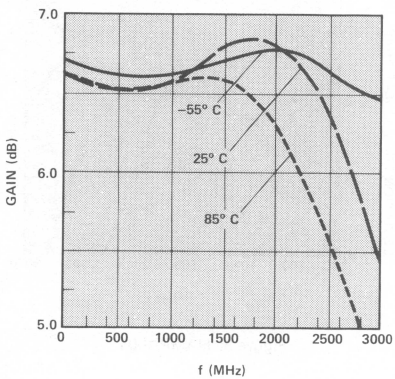


Figure. 1. HAMP-1001

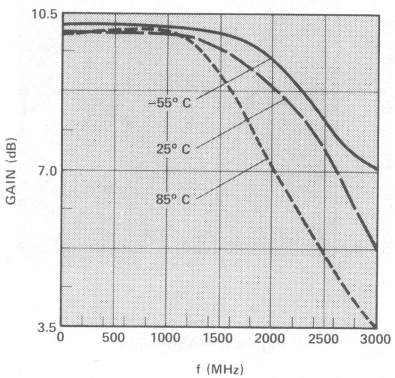


Figure 2. HAMP-1002

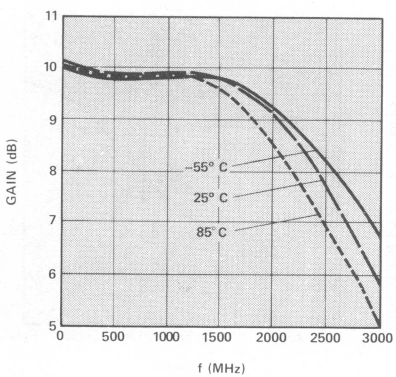


Figure 3. HAMP-1003

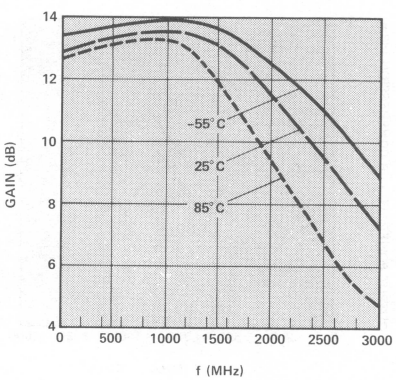


Figure 4. HAMP-1004

PHASE DEVIATION AT THREE TEMPERATURES

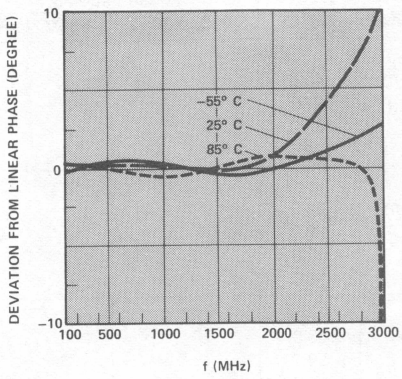


Figure. 5. HAMP-1001

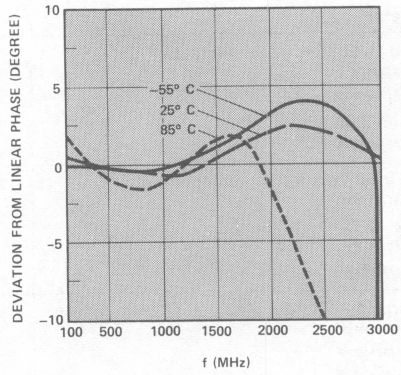


Figure 6. HAMP-1002

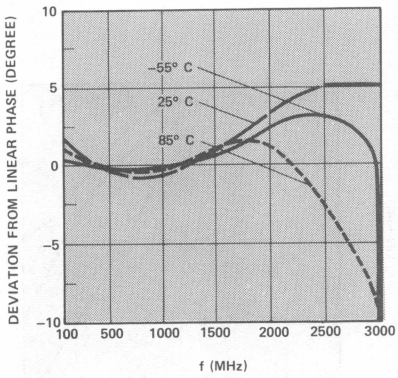


Figure 7. HAMP-1003

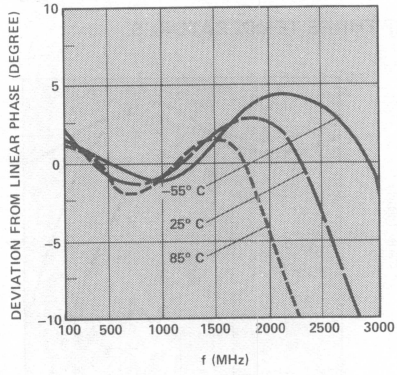


Figure 8. HAMP-1004

P_{1dB} AT 25°C

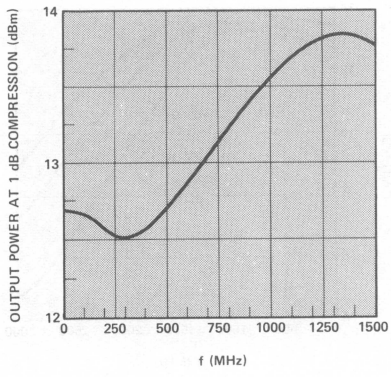


Figure. 9. HAMP-1001

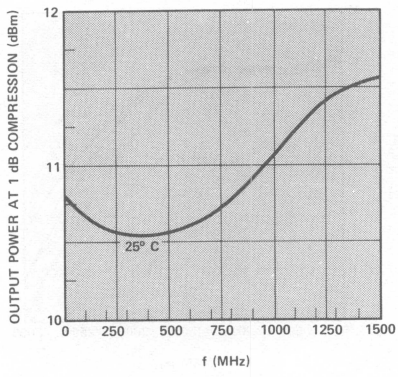


Figure 10. HAMP-1002

P_{1dB} AT 25° C (Cont.)

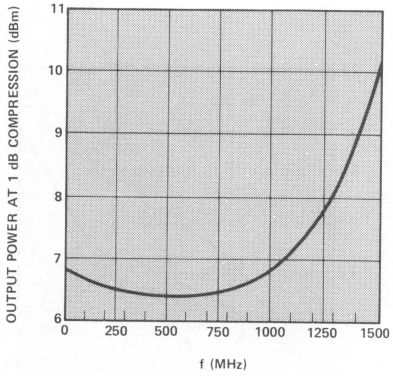


Figure 11. HAMP-1003

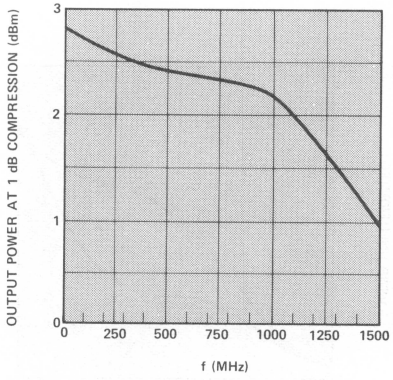


Figure 12. HAMP-1004

NOISE FIGURE AT THREE TEMPERATURES

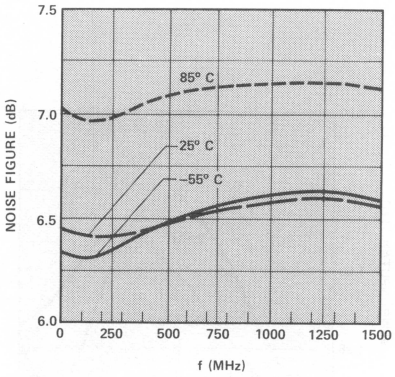


Figure. 13. HAMP-1001

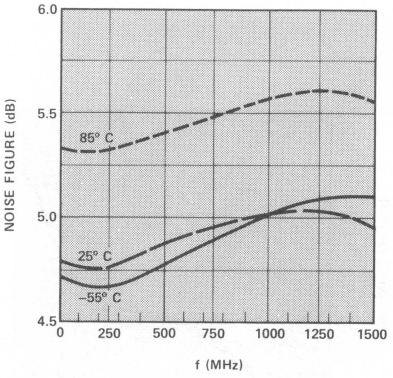


Figure 14. HAMP-1002

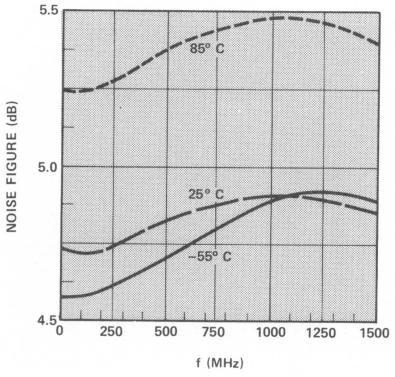


Figure 15. HAMP-1003

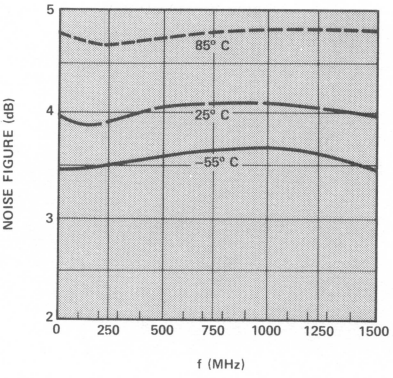


Figure 16. HAMP-1004

INPUT/OUTPUT VSWR AT 25°C

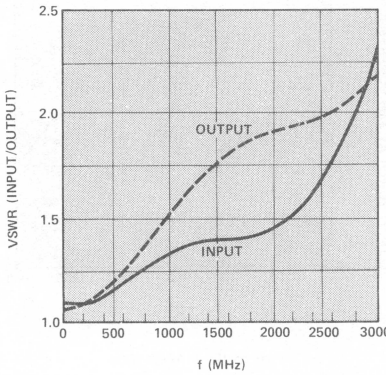


Figure. 17. HAMP-1001

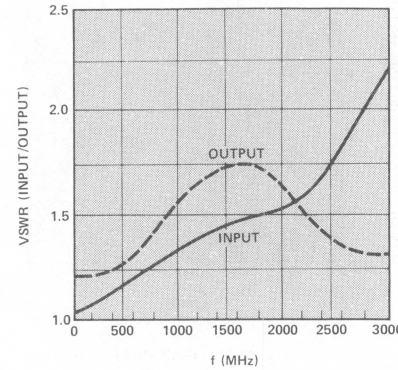


Figure 18. HAMP-1002

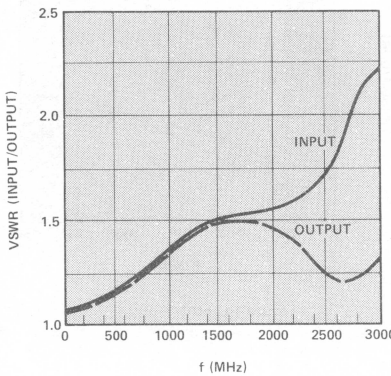


Figure 19. HAMP-1003

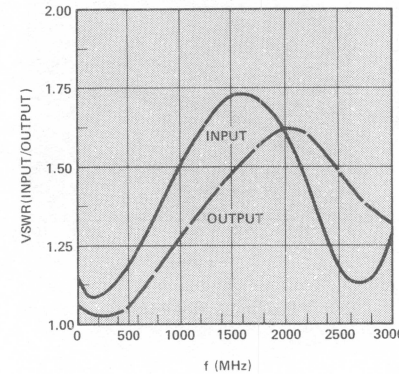


Figure 20. HAMP-1004

Typical S-Parameters at 25°C

HAMP-1001

Frequency (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.028	171	2.15	173	0.135	-1	0.035	-122
200	0.031	-127	2.13	168	0.130	1	0.043	-108
300	0.041	-114	2.13	162	0.132	3	0.063	-110
400	0.059	-113	2.12	155	0.133	3	0.080	-105
500	0.069	-112	2.12	148	0.133	4	0.101	-109
600	0.082	-110	2.12	143	0.135	5	0.124	-109
700	0.098	-113	2.12	137	0.136	6	0.142	-109
800	0.109	-114	2.11	131	0.139	6	0.160	-113
900	0.122	-116	2.11	125	0.141	7	0.182	-116
1000	0.133	-121	2.14	119	0.144	8	0.201	-119
1100	0.141	-123	2.15	113	0.147	8	0.221	-124
1200	0.152	-128	2.14	106	0.151	8	0.236	-129
1300	0.156	-135	2.17	100	0.151	8	0.252	-133
1400	0.163	-141	2.16	95	0.158	9	0.262	-138
1500	0.170	-149	2.18	89	0.163	9	0.270	-144
1600	0.168	-156	2.17	83	0.167	9	0.281	-151
1700	0.171	-167	2.20	77	0.171	8	0.292	-158
1800	0.172	-178	2.20	70	0.179	7	0.299	-167
1900	0.174	170	2.18	63	0.184	7	0.302	-173
2000	0.177	156	2.21	57	0.192	6	0.303	178
2100	0.183	141	2.15	50	0.202	3	0.314	166
2200	0.198	126	2.17	43	0.204	2	0.316	157
2300	0.215	110	2.16	37	0.212	1	0.313	144
2400	0.231	96	2.10	31	0.221	-2	0.324	131
2500	0.259	81	2.11	23	0.224	-5	0.326	119
2600	0.286	67	2.01	17	0.226	-8	0.329	104
2700	0.316	56	2.04	9	0.230	-10	0.342	91
2800	0.350	44	1.94	3	0.238	-13	0.346	80
2900	0.377	32	1.91	-4	0.240	-16	0.356	67
3000	0.391	23	1.84	-13	0.236	-19	0.386	59

HAMP-1002

Frequency (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.015	-102	3.20	172	0.103	2	0.022	-58
200	0.028	-111	3.19	167	0.103	1	0.021	-82
300	0.037	-100	3.18	161	0.104	3	0.047	-81
400	0.051	-99	3.16	154	0.106	3	0.052	-78
500	0.066	-98	3.18	148	0.106	5	0.065	-85
600	0.080	-101	3.15	142	0.108	5	0.085	-87
700	0.098	-105	3.16	135	0.108	6	0.098	-85
800	0.115	-109	3.17	128	0.109	7	0.111	-90
900	0.131	-112	3.15	122	0.111	8	0.132	-92
1000	0.146	-118	3.18	116	0.114	9	0.145	-93
1100	0.162	-124	3.16	109	0.115	10	0.159	-97
1200	0.171	-130	3.14	101	0.120	9	0.174	-103
1300	0.184	-139	3.13	94	0.119	9	0.183	-108
1400	0.192	-146	3.07	88	0.122	10	0.197	-112
1500	0.196	-156	3.04	81	0.126	10	0.200	-117
1600	0.204	-166	2.99	74	0.131	10	0.202	-122
1700	0.208	-177	2.96	68	0.134	11	0.209	-129
1800	0.203	171	2.89	61	0.139	9	0.203	-134
1900	0.205	158	2.83	53	0.140	8	0.194	-143
2000	0.208	143	2.79	47	0.147	8	0.187	-150
2100	0.220	129	2.69	40	0.153	6	0.175	-158
2200	0.227	113	2.62	33	0.154	4	0.160	-168
2300	0.238	97	2.55	27	0.159	4	0.139	-179
2400	0.255	83	2.43	20	0.165	2	0.118	165
2500	0.277	68	2.35	14	0.167	-1	0.104	149
2600	0.299	55	2.24	7	0.168	-2	0.090	127
2700	0.327	43	2.16	1	0.175	-3	0.089	103
2800	0.351	31	2.05	-5	0.181	-6	0.095	81
2900	0.371	20	1.95	-11	0.183	-9	0.111	61
3000	0.377	10	1.85	-18	0.182	-11	0.136	51

HAMP-1003

Frequency (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.017	-84	3.15	172	0.113	2	0.078	-18
200	0.029	-102	3.14	168	0.112	1	0.074	-30
300	0.040	-94	3.13	162	0.112	2	0.096	-47
400	0.054	-96	3.11	155	0.114	3	0.105	-52
500	0.069	-97	3.13	148	0.114	4	0.117	-62
600	0.082	-100	3.10	143	0.116	5	0.140	-69
700	0.099	-105	3.11	136	0.116	5	0.155	-73
800	0.114	-109	3.12	129	0.117	6	0.168	-79
900	0.130	-113	3.10	123	0.119	7	0.192	-84
1000	0.143	-118	3.15	117	0.121	8	0.207	-88
1100	0.158	-124	3.13	111	0.123	9	0.222	-93
1200	0.166	-130	3.12	103	0.128	8	0.236	-99
1300	0.178	-138	3.13	97	0.127	9	0.246	-105
1400	0.186	-145	3.07	91	0.130	9	0.261	-110
1500	0.190	-155	3.06	84	0.134	9	0.264	-116
1600	0.197	-164	3.02	77	0.140	10	0.266	-122
1700	0.200	-175	3.01	71	0.143	10	0.273	-129
1800	0.197	173	2.96	64	0.149	8	0.267	-135
1900	0.198	160	2.91	56	0.151	7	0.258	-143
2000	0.202	145	2.90	51	0.158	7	0.252	-151
2100	0.212	131	2.79	43	0.165	4	0.237	-160
2200	0.221	115	2.74	37	0.165	3	0.220	-169
2300	0.233	99	2.69	30	0.171	3	0.197	-179
2400	0.249	83	2.56	23	0.178	0	0.173	167
2500	0.272	68	2.49	16	0.179	-2	0.156	153
2600	0.294	55	2.37	9	0.180	-4	0.136	135
2700	0.322	42	2.30	3	0.187	-5	0.127	115
2800	0.347	31	2.17	-3	0.192	-8	0.125	94
2900	0.368	20	2.07	-10	0.193	-11	0.132	73
3000	0.377	10	1.97	-16	0.191	-13	0.151	59

HAMP-1004

Frequency (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
100	0.035	113	4.44	173	0.124	-3	0.010	-132
200	0.027	84	4.47	163	0.126	-5	0.010	50
300	0.054	69	4.53	154	0.127	-6	0.022	27
400	0.073	55	4.55	146	0.125	-10	0.032	25
500	0.090	42	4.57	136	0.133	-14	0.036	20
600	0.117	28	4.60	127	0.133	-15	0.049	5
700	0.138	14	4.63	118	0.129	-20	0.064	-7
800	0.159	3	4.65	108	0.129	-22	0.081	-22
900	0.184	-10	4.68	98	0.133	-26	0.096	-31
1000	0.208	-20	4.66	88	0.133	-29	0.119	-37
1100	0.226	-30	4.65	78	0.132	-31	0.137	-43
1200	0.240	-40	4.65	69	0.136	-34	0.146	-51
1300	0.251	-50	4.59	58	0.136	-37	0.162	-59
1400	0.260	-59	4.51	48	0.138	-41	0.175	-69
1500	0.270	-71	4.40	38	0.136	-43	0.197	-77
1600	0.274	-81	4.30	28	0.134	-46	0.205	-87
1700	0.271	-91	4.09	17	0.138	-49	0.222	-95
1800	0.259	-102	3.93	8	0.140	-51	0.224	-104
1900	0.247	-112	3.81	-1	0.139	-54	0.233	-110
2000	0.230	-123	3.63	-11	0.140	-57	0.237	-117
2100	0.219	-130	3.51	-20	0.147	-60	0.235	-124
2200	0.191	-136	3.33	-28	0.148	-63	0.228	-131
2300	0.163	-143	3.16	-37	0.150	-66	0.220	-138
2400	0.126	-152	3.00	-45	0.154	-69	0.207	-147
2500	0.093	-165	2.88	-54	0.158	-72	0.198	-156
2600	0.065	172	2.73	-62	0.161	-76	0.189	-162
2700	0.048	127	2.62	-69	0.166	-79	0.176	-169
2800	0.064	83	2.50	-77	0.169	-83	0.160	-176
2900	0.092	60	2.39	-85	0.171	-85	0.142	176
3000	0.118	42	2.28	-92	0.178	-89	0.139	163

Typical Performance Parameters at 25°C

HAMP-1001

Frequency (MHz)	Linear Phase Deviation (deg.)	Relative Phase (deg.)	Gain Deviation (dB)	Gain Absolute (dB)	Group Delay (ns)	Input VSWR	Output VSWR
10				6.60		1.20	1.30
100	0.48	0	0.04	6.63	0.18	1.06	1.07
200	-0.55	-5	-0.05	6.55	0.14	1.06	1.09
300	-0.73	-11	-0.03	6.56	0.16	1.09	1.13
400	0.29	-18	-0.05	6.54	0.20	1.12	1.17
500	0.73	-24	-0.06	6.54	0.18	1.15	1.22
600	-0.04	-30	-0.08	6.51	0.15	1.18	1.28
700	0.10	-36	-0.08	6.52	0.17	1.22	1.33
800	0.21	-42	-0.10	6.50	0.17	1.25	1.38
900	-0.38	-47	-0.10	6.50	0.15	1.28	1.44
1000	-0.40	-53	0.02	6.62	0.17	1.31	1.50
1100	-0.18	-60	0.05	6.65	0.17	1.33	1.57
1200	0.36	-66	0.03	6.63	0.18	1.36	1.62
1300	0.41	-72	0.12	6.72	0.17	1.37	1.67
1400	-0.20	-78	0.09	6.68	0.15	1.39	1.71
1500	-0.10	-84	0.19	6.79	0.17	1.41	1.74
1600	0.04	-90	0.14	6.73	0.17	1.40	1.78
1700	-0.10	-96	0.24	6.84	0.16	1.41	1.83
1800	0.63	-103	0.23	6.83	0.19	1.41	1.85
1900	1.83	-110	0.18	6.78	0.20	1.42	1.86
2000	1.55	-116	0.30	6.90	0.16	1.43	1.87
2100	2.22	-123	0.06	6.65	0.19	1.45	1.91
2200	2.82	-129	0.15	6.74	0.18	1.49	1.92
2300	3.26	-136	0.08	6.67	0.18	1.55	1.91
2400	3.41	-142	-0.14	6.45	0.17	1.60	1.96
2500	4.90	-149	-0.12	6.48	0.21	1.70	1.97
2600	5.52	-156	-0.54	6.86	0.19	1.80	1.98
2700	6.98	-163	-0.40	7.20	0.21	1.93	2.04
2800	6.59	-169	-0.82	5.78	0.16	2.08	2.06
2900	8.48	-177	-0.99	5.61	0.22	2.21	2.10
3000	11.29	-186	-1.28	5.32	0.25	2.29	2.26

Typical Performance Parameters at 25°C

HAMP-1002

Frequency (MHz)	Linear Phase Deviation (deg.)	Relative Phase (deg.)	Gain Deviation (dB)	Gain Absolute (dB)	Group Delay (ns)	Input VSWR	Output VSWR
10				10.10		1.20	1.20
100	1.76	0	0.13	10.09	0.23	1.03	1.05
200	0.06	-5	0.10	10.07	0.14	1.06	1.04
300	-0.51	-11	0.08	10.05	0.17	1.08	1.10
400	-0.01	-18	0.02	9.99	0.20	1.11	1.11
500	-0.05	-25	0.09	10.05	0.18	1.14	1.14
600	-0.02	-30	-0.00	9.96	0.16	1.17	1.19
700	-0.33	-37	0.03	10.00	0.20	1.22	1.22
800	-0.21	-44	0.05	10.02	0.19	1.26	1.25
900	-0.54	-50	-0.01	9.96	0.17	1.30	1.30
1000	-0.99	-57	0.09	10.06	0.17	1.34	1.34
1100	-0.53	-64	0.04	10.00	0.20	1.39	1.38
1200	0.39	-71	-0.03	9.93	0.21	1.41	1.42
1300	0.63	-78	-0.05	9.91	0.19	1.45	1.45
1400	0.54	-84	-0.23	9.73	0.18	1.48	1.49
1500	0.60	-91	-0.31	9.66	0.18	1.49	1.50
1600	1.28	-98	-0.45	9.52	0.20	1.51	1.51
1700	0.65	-104	-0.54	9.42	0.17	1.52	1.53
1800	1.12	-111	-0.76	9.21	0.20	1.51	1.51
1900	2.48	-119	-0.93	9.04	0.22	1.51	1.48
2000	1.54	-125	-1.06	8.91	0.16	1.53	1.46
2100	2.35	-132	-1.38	8.59	0.21	1.56	1.42
2200	2.09	-139	-1.60	8.36	0.18	1.59	1.38
2300	1.91	-145	-1.83	8.14	0.18	1.62	1.32
2400	1.92	-152	-2.26	7.71	0.18	1.68	1.27
2500	2.12	-159	-2.54	7.43	0.19	1.77	1.23
2600	2.18	-165	-2.97	6.99	0.18	1.85	1.20
2700	1.37	-171	-3.26	6.70	0.16	1.97	1.20
2800	1.18	-177	-3.75	6.22	0.18	2.08	1.21
2900	0.57	-183	-4.17	5.80	0.17	2.18	1.25
3000	0.55	-190	-4.60	5.37	0.18	2.21	1.32

Typical Performance Parameters at 25°C

HAMP-1003

Frequency (MHz)	Linear Phase Deviation (deg.)	Relative Phase (deg.)	Gain Deviation (dB)	Gain Absolute (dB)	Group Delay (ns)	Input VSWR	Output VSWR
10				10.00		1.30	1.40
100	1.56	0	0.10	9.98	0.22	1.03	1.17
200	-0.07	-5	0.07	9.95	0.13	1.06	1.16
300	-0.51	-11	0.04	9.92	0.16	1.08	1.21
400	0.01	-18	-0.01	9.87	0.19	1.11	1.24
500	0.01	-24	0.04	9.92	0.18	1.15	1.26
600	-0.63	-30	-0.04	9.83	0.16	1.18	1.32
700	-0.20	-36	-0.01	9.86	0.19	1.22	1.37
800	-0.16	-43	0.01	9.88	0.18	1.26	1.41
900	-0.34	-49	-0.05	9.83	0.17	1.30	1.48
1000	-0.93	-55	0.08	9.96	0.16	1.33	1.52
1100	-0.63	-62	0.03	9.91	0.19	1.37	1.57
1200	0.39	-69	-0.00	9.88	0.21	1.40	1.62
1300	0.53	-75	0.03	9.90	0.18	1.43	1.65
1400	0.48	-82	-0.13	9.74	0.18	1.46	1.71
1500	0.51	-88	-0.16	9.72	0.18	1.47	1.72
1600	1.54	-96	-0.27	9.65	0.21	1.49	1.73
1700	0.85	-101	-0.30	9.58	0.16	1.50	1.75
1800	1.37	-103	-0.46	9.45	0.19	1.45	1.73
1900	3.26	-116	-0.60	9.22	0.23	1.49	1.69
2000	2.35	-122	-0.63	9.25	0.15	1.51	1.67
2100	3.66	-129	-0.96	8.92	0.21	1.54	1.62
2200	3.58	-136	-1.12	8.75	0.17	1.57	1.56
2300	3.86	-143	-1.29	8.59	0.18	1.61	1.49
2400	4.37	-149	-1.71	6.17	0.19	1.66	1.42
2500	4.88	-156	-1.94	7.94	0.19	1.75	1.37
2600	5.60	-163	-2.39	7.49	0.20	1.83	1.31
2700	5.11	-169	-2.64	7.24	0.16	1.95	1.29
2800	5.34	-176	-3.15	6.73	0.18	2.06	1.28
2900	5.13	-183	-3.55	6.30	0.17	2.17	1.30
3000	5.20	-183	-4.00	5.83	0.18	2.21	1.36

Typical Performance Parameters at 25°C

HAMP-1004

Frequency (MHz)	Linear Phase Deviation (deg.)	Relative Phase (deg.)	Gain Deviation (dB)	Gain Absolute (dB)	Group Delay (ns)	Input VSWR	Output VSWR
10				12.90		1.30	1.20
100	1.59	0	-0.25	12.95	0.31	1.07	1.02
200	1.21	-9	-0.20	13.00	0.26	1.06	1.02
300	0.70	-18	-0.08	13.12	0.25	1.11	1.04
400	-0.28	-27	-0.04	13.16	0.24	1.16	1.07
500	-0.66	-36	-0.01	13.19	0.26	1.20	1.08
600	-0.84	-46	0.05	13.25	0.26	1.26	1.10
700	-1.07	-55	0.12	13.32	0.26	1.32	1.14
800	-1.34	-65	0.15	13.35	0.26	1.38	1.18
900	-0.98	-75	0.20	13.40	0.28	1.45	1.21
1000	-0.93	-84	0.17	13.37	0.27	1.53	1.27
1100	-0.45	-94	0.15	13.35	0.28	1.58	1.32
1200	-0.44	-104	0.15	13.35	0.27	1.63	1.34
1300	0.56	-115	0.04	13.24	0.30	1.67	1.39
1400	1.27	-125	-0.11	13.09	0.29	1.70	1.42
1500	1.66	-135	-0.33	12.87	0.28	1.74	1.49
1600	2.09	-145	-0.53	12.67	0.28	1.76	1.52
1700	3.17	-156	-0.97	12.23	0.30	1.74	1.57
1800	2.39	-165	-1.31	11.89	0.25	1.70	1.58
1900	2.00	-174	-1.57	11.63	0.26	1.66	1.61
2000	1.91	-183	-2.01	11.19	0.27	1.60	1.62
2100	1.21	-192	-2.29	10.91	0.25	1.56	1.62
2200	0.31	-201	-2.76	10.44	0.24	1.47	1.59
2300	-0.48	-210	-3.20	10.00	0.25	1.39	1.56
2400	-2.27	-218	-3.65	9.55	0.22	1.29	1.52
2500	-3.15	-227	-4.00	9.20	0.24	1.21	1.50
2600	-4.70	-235	-4.48	8.72	0.22	1.14	1.47
2700	-7.49	-241	-4.82	8.38	0.19	1.10	1.43
2800	-8.85	-250	-5.25	7.95	0.23	1.14	1.38
2900	-10.97	-257	-5.62	7.58	0.21	1.20	1.33
3000	-13.17	-265	-6.03	7.17	0.21	1.27	1.32

HIGH RELIABILITY AMPLIFIER PRODUCTS

Since the advantages of products tested to well established reliability screening standards can be of significant value to reliability oriented customers, HP makes available products with Hi-Rel screening and testing patterned after MIL-STD-833, Method 5004 latest revision.

The table below depicts the screening program for this family of amplifiers.

100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-883 Test Method	Conditions/Comments
1. Internal Visual Inspection (PreCap)	2017	
2. High Temperature Storage (Stabilization Bake)	1008	Condition B T = 125°C, t = 24 hours
3. Temperature Cycling	1010	Condition B -55°C to 125°C
4. Constant Acceleration	2001	Condition B 20 kg's, Y_1 Direction
5. Pre Burn-in Electrical	—	Per Applicable Device Specification
6. Burn-in	1015	t = 168 hours T_A = 25°C and 80% of Rated Bias Conditions
7. Post Burn-in Electrical (PDA ≤10%)	—	Per Applicable Device Specification
8. Hermeticity Tests (Fine and Gross)	1014	Conditions A and C
9. Final Electrical Tests	—	Per Applicable Device Specification
10. External Visual Inspection	2009	

Note: Additional tests, screens and qualification testings (e.g.: X-ray, PIND, Extended Burn-in, and Lot Qualification) are available on request.

Ordering Information

Add suffix TXV to standard part number.

Example: Standard Product HAMP-1001, HAMP-1002, HAMP-1003, HAMP-1004
Hi-Rel Product HAMP-1001TXV, HAMP-1002TXV, HAMP-1003TXV, HAMP-1004TXV

HEWLETT PACKARD

VARIABLE GAIN WIDEBAND AMPLIFIERS

HAMP-4001
HAMP-4002
TXV VERSIONS

Features

WIDE GAIN CONTROL RANGE > 30 dB

WIDE BANDWIDTH
2 MHz to 1900 MHz for Digital Applications
10 MHz to 1900 MHz for Linear Applications

FLATNESS OVER GAIN CONTROL RANGE
±0.6 dB Typical

15 V DC AMPLIFIER SUPPLY

5 V DC GAIN CONTROL

GUARANTEED PERFORMANCE OVER TEMPERATURE RANGE
-55°C to +85°C

EASILY CASCADABLE IN 50 OHM SYSTEMS

FAST, PRECISE GAIN CONTROL RESPONSE USING HP PIN DIODES

Description/Applications

The HAMP-4001 and -4002 are thin-film hybrid, variable gain amplifiers using bipolar transistors. The design uses low capacitance PIN diodes to acheive a wide gain control range with extremely uniform gain flatness. The internal bias network and coupling capacitors eliminate the need for external bias circuitry. The amplifier is ideal for IF, RF, and high speed digital applications.

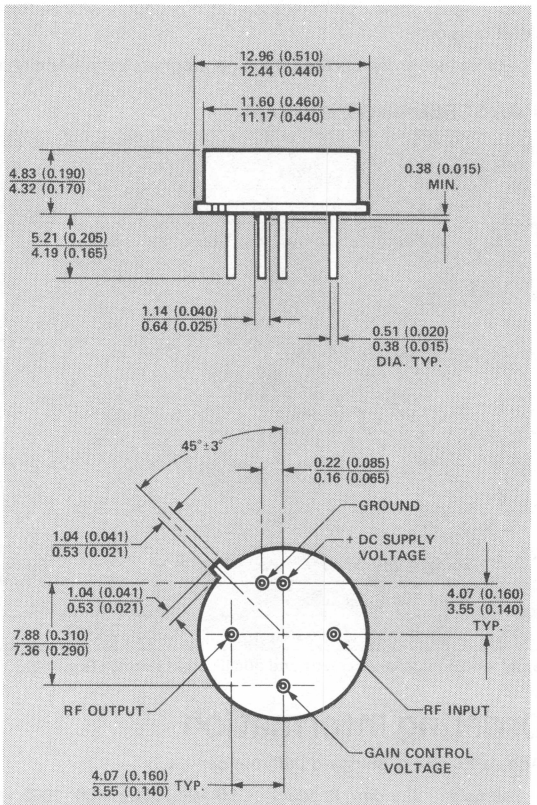
The HAMP-4000 series amplifiers are supplied in a standard, 5-pin, rugged TO-8 package and are capable of meeting the environmental requirements of MIL-S-19500 and the test requirements of MIL-STD-883.

Absolute Maximum Ratings*

Supply Voltage	30.0 V
DC Withstanding Voltage, Input/Output	30.0 V
Gain Voltage	20.0 Volts
Continuous RF Input Power	+15 dBm
Short Term RF Input Power (CW/1 min Duration)	+20 dBm
Max RF Peak Input Power (3 microsecond Pulse, 1 Single Pulse)	+27 dBm
Operating Case Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C

**Operation in excess of these conditions may result in permanent damage to the device.*

MTTF: (Calculated by MIL-STD-217D)
In excess of 2.3×10^6 hours at T_{case} = +85°C.



DIMENSIONS IN MILLIMETERS AND (INCHES).

HP OUTLINE TO-8A
WEIGHT (TYPICAL): 1.95 GRAMS

Electrical Specifications

HAMP-4001 Supply Voltage = +15 V, V_{GC} = +5 V

Symbol	Parameters	Units	Typ. 25°C
f_{HIGH} (-1 dB)	Upper frequency for 1 dB Bandwidth	MHz	830
f_{HIGH} (-3 dB)	Upper frequency for 3 dB Bandwidth	MHz	1360
f_{LOW} (-3 dB)	Lower frequency for 3 dB Bandwidth	MHz	2
f_{HIGH} (-3 dB) GCR	Upper frequency for 3 dB Bandwidth over entire GC range*	MHz	1250

HAMP-4001 Specifications over frequency range 10 MHz–1000 MHz, Supply Voltage = +15 V, V_{GC} = +5 V

				Guaranteed					
				0°C to 50°C			-55°C to 85°C		
Symbol	Parameters	Units	Typ. 25°C	Typ.	Min.	Max.	Typ.	Min.	Max.
$\|S_{21}\|^2$	Small Signal Gain @500 MHz @1 GHz	dB	22.5 22.7 21	22.5 21	20 18.6	— —	22 19.5	19.4 16.0	— —
G_{flat}	Gain Flatness	±dB	1.0			2.0			2.0
GCR	Gain Control Range*	dB	30.0		27.0			22.0	
NF	Noise Figure	dB	4.8			6.0			6.0
$P_{1\,dB}$	Output Power 1 dB Gain Compression	dBm	10.1		7.5			5.5	
IP_3	Third Order Intercept Point 2 Tone at 100 MHz	dBm	21						
IP_2	Second Order Intercept Point 2 Tone at 100 MHz	dBm	35						
VSWR I/O	Voltage Standing Wave Ratio over entire GC range		1.2			2.0			2.0
$\|S_{12}\|^2$	Isolation	dB	48						
t_g	Group Delay	nS	0.6						
I_{cc}	Input Current, Supply	mA	95						
I_{gc}	Input Current, Gain Control	mA	17			25			25

Standard Conditions: Input/Output Impedance ..... 50 Ohms Resistive

*Gain Control Range is the attenuation range over which the gain flatness is within 3 dB.
V_{GC} @ Max Gain ..... +5 V
V_{GC} @ Min Gain (for 3 dB flatness) ..... +0.75 V Typical

Electrical Specifications

HAMP-4002 Supply Voltage = +15 V, V_{gc} = +5 V

Symbol	Parameters	Units	Typ. 25°C
f_{HIGH} (-1 dB)	Upper frequency for 1 dB Bandwidth	MHz	1450
f_{HIGH} (-3 dB)	Upper frequency for 3 dB Bandwidth	MHz	1870
f_{LOW} (-3 dB)	Lower frequency for 3 dB Bandwidth	MHz	2
f_{HIGH} (-3 dB) GCR	Upper frequency for 3 dB Bandwidth over entire AGC range*	MHz	1630

HAMP-4002 Specifications over frequency range 10 MHz-1500 MHz, Supply Voltage = +15 V, V_{gc} = +5 V

Symbol	Parameters	Units	Typ. 25°C	Guaranteed					
				0°C to 50°C			-55°C to 85°C		
				Typ.	Min.	Max.	Typ.	Min.	Max.
$\|S_{21}\|^2$	Small Signal Gain @500 MHz @1500 MHz	dB	17.3 17.4 16.3	 17.3 16.1	 16.0 14.0	 — —	 17.1 14.2	 15.6 11.5	 — —
G_{flat}	Gain Flatness	±dB	0.6			2.0			2.5
GCR	Gain Control Range*	dB	29.0		25.0			24.0	
NF	Noise Figure	dB	5.7			7.0			7.5
$P_{1\,dB}$	Output Power 1 dB Gain Compression	dBm	10		7.5			5.3	
IP_3	Third Order Intercept Point 2 Tone at 100 MHz	dBm	21						
IP_2	Second Order Intercept Point 2 Tone at 100 MHz	dBm	39						
VSWR I/O	Voltage Standing Wave Ratio over entire GC range		1.3			2.2			2.4
$\|S_{12}\|^2$	Isolation	dB	42						
t_g	Group Delay	nS	0.5						
I_{cc}	Input Current, Supply	mA	95						
I_{gc}	Input Current, Gain Control	mA	17			25			25

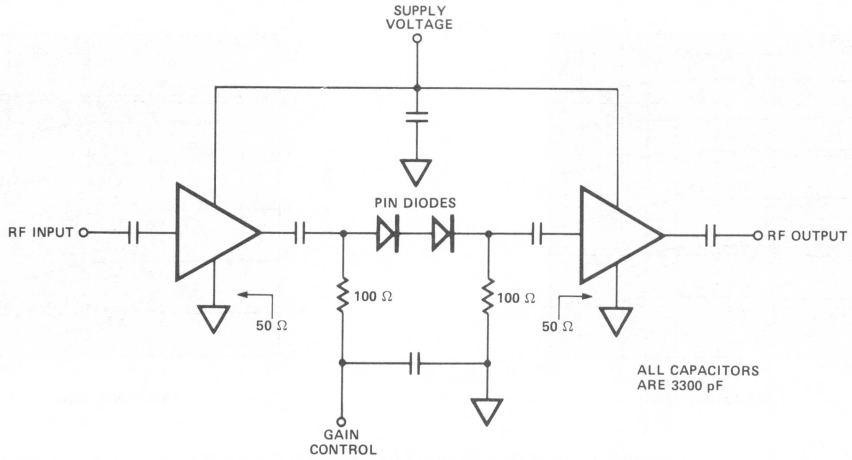
Standard Conditions: Input/Output Impedance ..... 50 Ohms Resistive

*Gain Control Range is the attenuation range over which the gain flatness is within 3 dB.

V_{gc} @ Max Gain ..... +5 V

V_{gc} @ Min Gain (for 3 dB flatness) ..... +0.75 V Typical

SCHEMATIC DIAGRAM HAMP-4001/-4002



Typical Performance

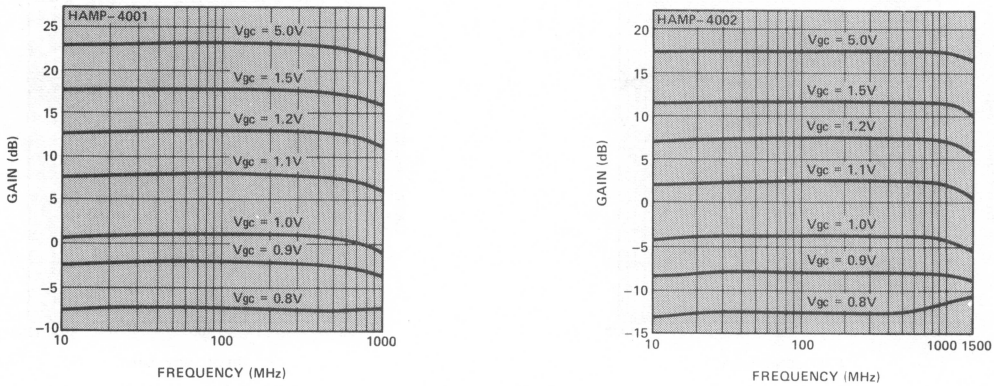


Figure 1. Gain vs. Frequency at 7 Gain Levels over Gain Control Range at T_{case} = 25°C

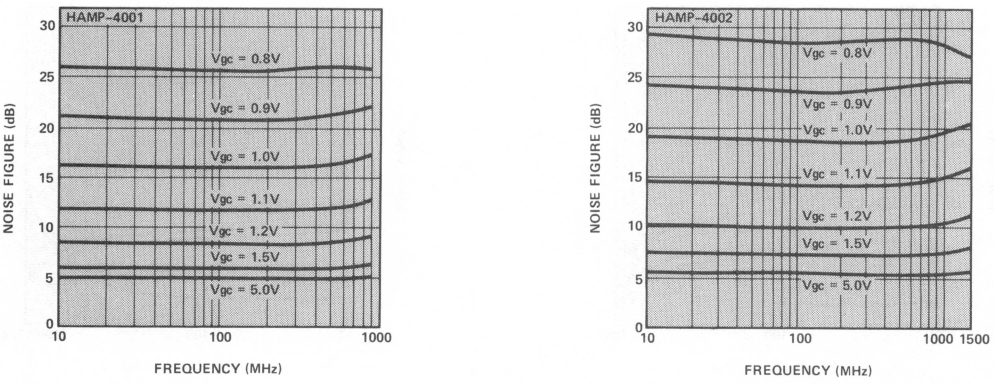


Figure 2. Noise Figure vs. Frequency at 7 Gain Levels at T_{case} = 25°C

Typical Performance (cont.)

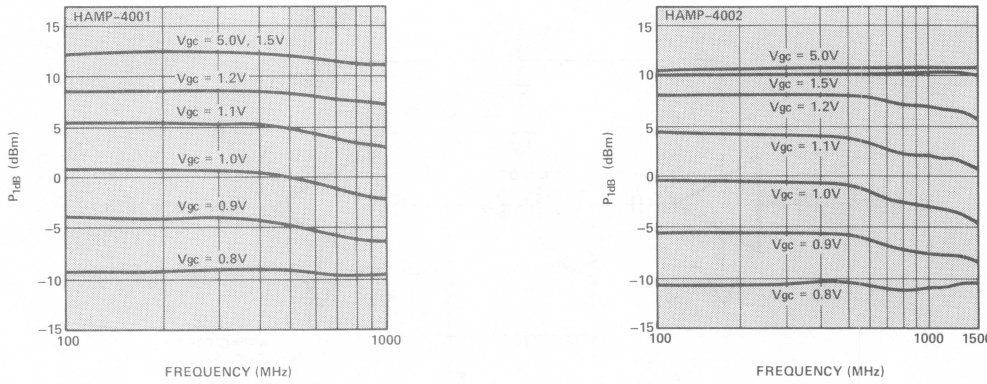


Figure 3. $P_{1\ dB}$ vs. Frequency at 7 Gain Levels at T_{case} = 25°C

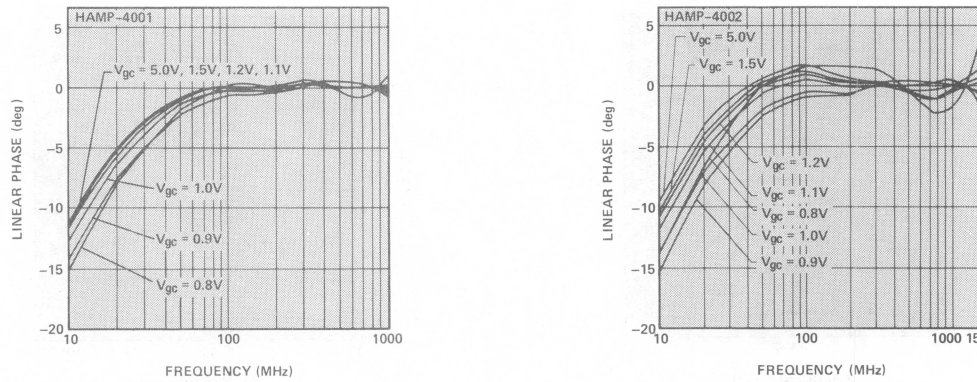


Figure 4. Linear Phase vs. Frequency at 7 Gain Levels at T_{case} = 25°C

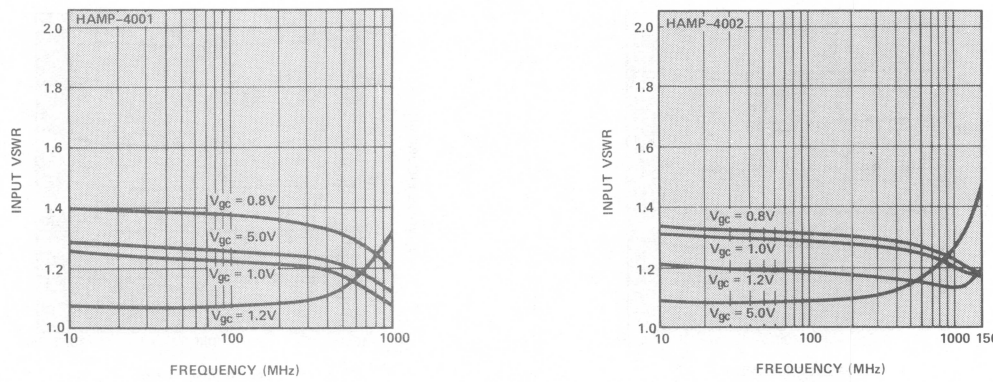


Figure 5. Input VSWR vs. Frequency at 7 Gain Levels at T_{case} = 25°C

Typical Performance (cont.)

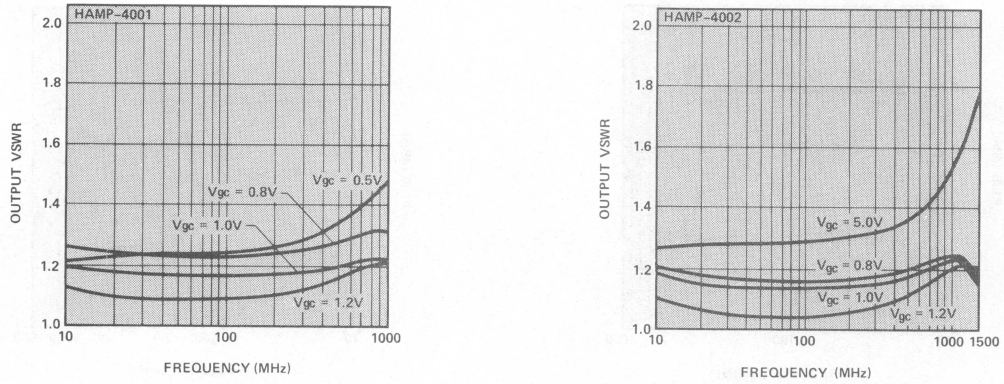


Figure 6. Output VSWR vs. Frequency at 7 Gain Levels at T_{case} = 25°C

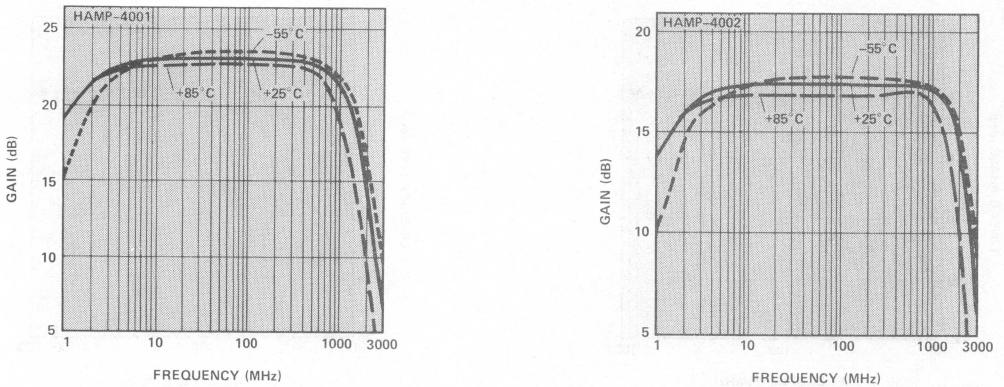


Figure 7. Gain vs. Frequency at Three Temperatures

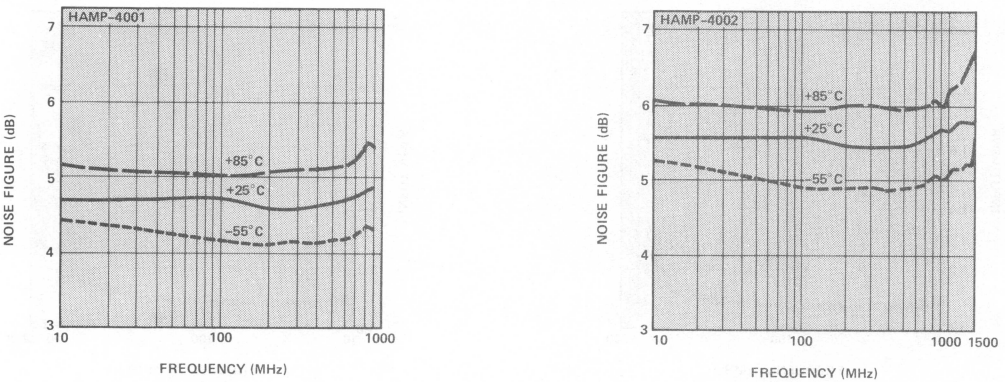


Figure 8. Noise Figure vs. Frequency at Maximum Gain at Three Temperatures

Typical Performance (cont.)

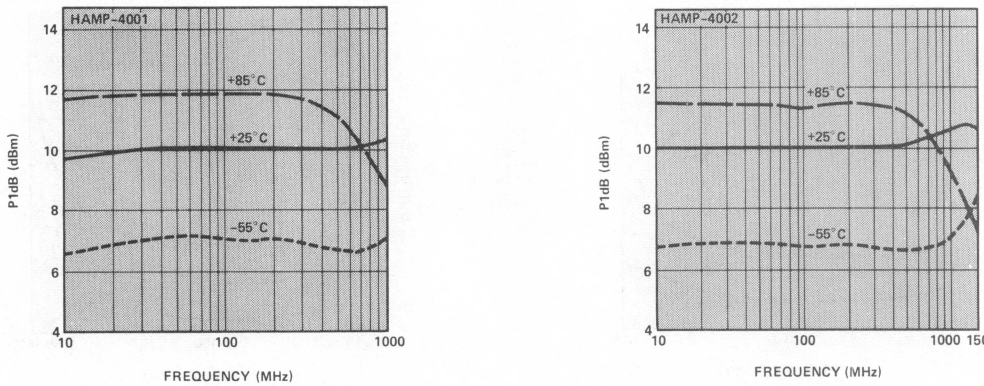


Figure 9. $P_{1\,dB}$ vs. Frequency at Maximum Gain at Three Temperatures

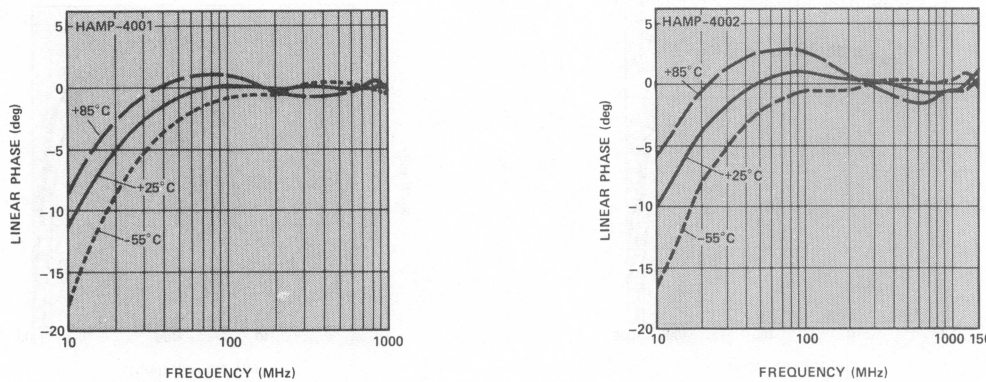


Figure 10. Phase Linearity vs. Frequency at Maximum Gain at Three Temperatures

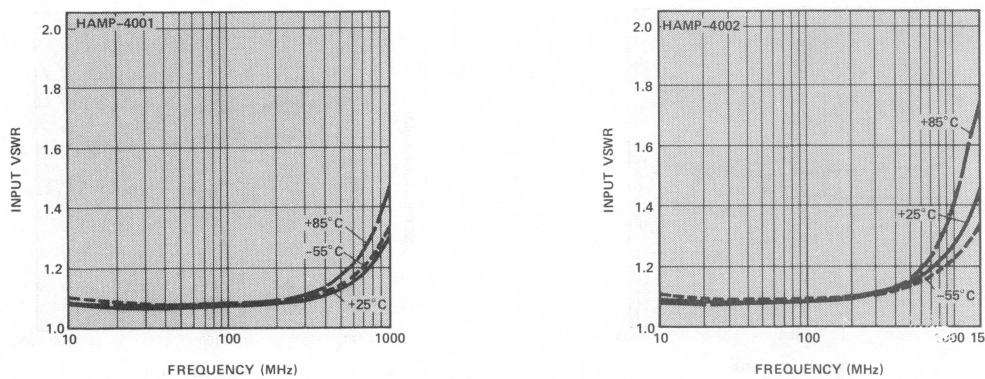


Figure 11. Input VSWR vs. Frequency at Maximum Gain at Three Temperatures

Typical Performance (cont.)

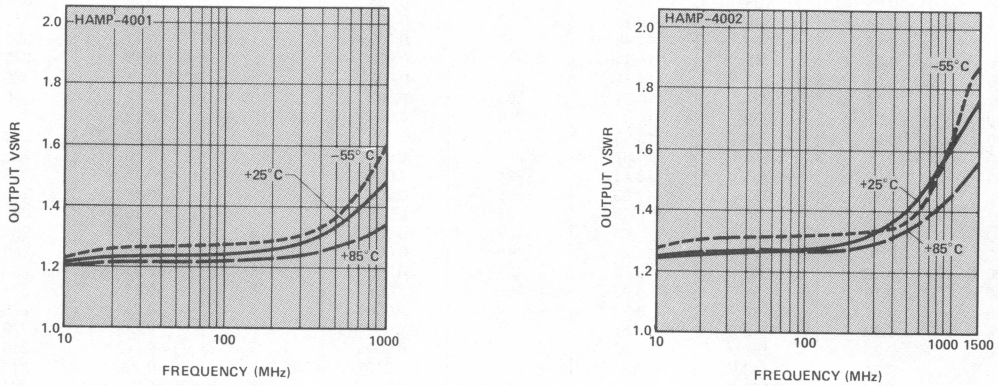


Figure 12. Output VSWR vs. Frequency at Maximum Gain at Three Temperatures

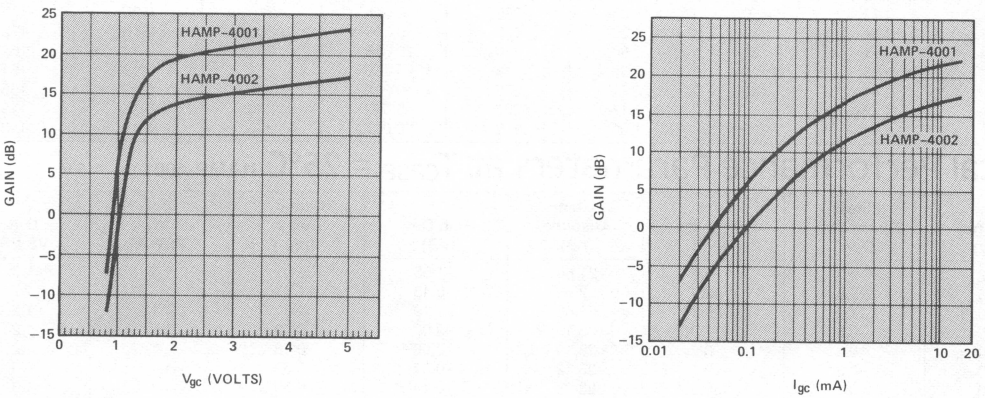


Figure 13a. Gain vs. V_{gc} at 100 MHz at T_{case} = 25°C

Figure 13b. Gain vs. I_{gc} at 100 MHz at T_{case} = 25°C

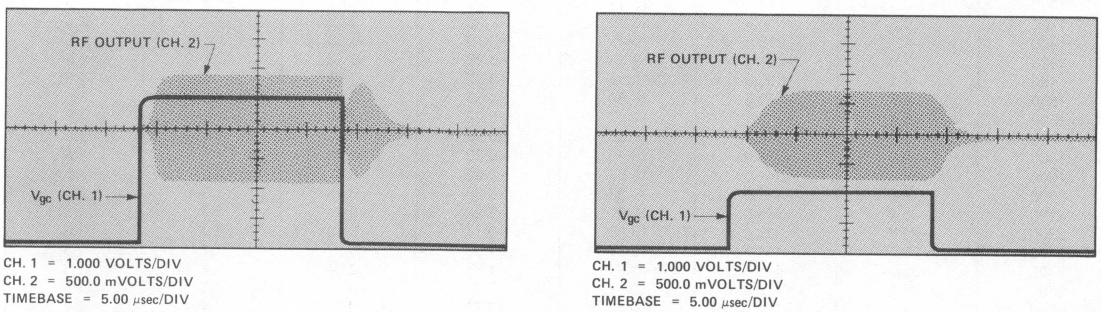


Figure 14. Change in Gain with Turn On/Off of V_{gc} vs. Time (200 MHz Signal) at T_{case} = 25°C

Typical S-Parameters at T_{case} = 25°C **HAMP-4001** Supply Voltage = 15 V, V_{gc} = 5 V

Frequency (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
2	0.14	273	12.07	61	0.003	23	0.12	271
5	0.05	298	13.74	25	0.003	15	0.08	351
10	0.04	326	14.13	12	0.003	10	0.10	358
50	0.03	350	14.43	353	0.003	1	0.11	353
100	0.04	349	14.44	342	0.003	5	0.11	345
200	0.04	337	14.32	323	0.003	8	0.11	330
300	0.04	324	14.21	303	0.003	10	0.12	315
400	0.05	309	14.04	283	0.004	13	0.13	303
500	0.06	294	13.83	264	0.004	15	0.14	292
600	0.07	279	13.57	244	0.004	15	0.16	282
700	0.09	265	13.23	224	0.004	16	0.17	273
800	0.10	253	12.82	205	0.005	16	0.18	265
900	0.12	240	12.33	185	0.005	14	0.19	257
1000	0.14	229	11.80	165	0.006	13	0.19	250
1100	0.16	217	11.21	146	0.006	12	0.20	243
1200	0.18	206	10.59	127	0.007	8	0.21	237
1300	0.19	194	9.92	108	0.007	6	0.21	231
1400	0.21	182	9.24	89	0.008	2	0.21	226
1500	0.22	170	8.57	71	0.009	357	0.21	220
1600	0.23	157	7.92	53	0.009	353	0.22	215
1700	0.24	143	7.27	36	0.010	348	0.22	210
1800	0.26	128	6.65	18	0.011	343	0.22	204
1900	0.27	114	6.07	1	0.011	338	0.22	199
2000	0.29	99	5.51	345	0.012	332	0.21	194
2100	0.31	85	5.00	329	0.013	327	0.21	189
2200	0.33	71	4.51	313	0.013	321	0.21	184
2300	0.35	59	4.06	298	0.014	315	0.20	179
2400	0.37	50	3.68	286	0.015	310	0.20	176
2500	0.39	41	3.32	273	0.015	305	0.19	172
2600	0.41	31	2.98	260	0.016	297	0.18	167
2700	0.43	23	2.68	246	0.016	291	0.18	161
2800	0.44	15	2.41	233	0.016	285	0.17	156
2900	0.45	7	2.17	220	0.017	280	0.17	149
3000	0.46	0	1.96	207	0.017	273	0.17	143

Typical Performance Parameters at T_{case} = 25°C **HAMP-4001** V_{gc} = 5 V

Frequency (MHz)	Linear Phase Dev. (Deg.)	Rel. Phase (Deg.)	Gain Absolute (dB)	Gain Dev. (dB)	Group Delay (ns)	In VSWR	Out VSWR
2	-59.3	79.0	21.64	-1.55	108.01	1.3	1.3
5	-23.8	42.9	22.76	-0.43	14.77	1.1	1.2
10	-11.3	29.4	23.00	-0.19	4.81	1.1	1.2
50	-0.8	11.0	23.19	-0.00	0.70	1.1	1.2
100	0.3	0.0	23.19	0.00	0.58	1.1	1.2
200	-0.3	-19.1	23.12	-0.07	0.55	1.1	1.3
300	0.1	-39.2	23.05	-0.14	0.55	1.1	1.3
400	0.0	-58.8	22.95	-0.24	0.54	1.1	1.3
500	-0.2	-78.4	22.82	-0.37	0.55	1.1	1.3
600	-0.1	-98.1	22.65	-0.54	0.55	1.2	1.4
700	-0.1	-117.9	22.43	-0.76	0.55	1.2	1.4
800	-0.1	-137.6	22.16	-1.04	0.55	1.2	1.4
900	0.4	-157.8	21.82	-1.37	0.55	1.3	1.5
1000	-0.0	-177.1	21.44	-1.75	0.54	1.3	1.5
1100	-0.5	-196.4	20.99	-2.20	0.53	1.4	1.5
1200	-1.1	-215.5	20.49	-2.70	0.53	1.4	1.5
1300	-1.9	-234.4	19.93	-3.26	0.52	1.5	1.5
1400	-3.1	-252.9	19.32	-3.87	0.51	1.5	1.5
1500	-4.5	-271.2	18.66	-4.53	0.50	1.6	1.5
1600	-6.4	-289.1	17.97	-5.22	0.49	1.6	1.6
1700	-8.5	-306.7	17.23	-5.96	0.49	1.6	1.6
1800	-10.9	-324.0	16.46	-6.73	0.48	1.7	1.6
1900	-13.6	-341.0	15.67	-7.53	0.47	1.7	1.5
2000	-16.8	-357.6	14.83	-8.36	0.45	1.8	1.5
2100	-20.4	-373.6	13.97	-9.22	0.44	1.9	1.5
2200	-24.3	-389.4	13.08	-10.11	0.43	2.0	1.5
2300	-28.7	-404.8	12.16	-11.03	0.37	2.1	1.5
2400	-36.9	-416.4	11.32	-11.87	0.34	2.2	1.5
2500	-44.1	-428.8	10.42	-12.77	0.37	2.3	1.5
2600	-49.9	-442.7	9.48	-13.71	0.38	2.4	1.4
2700	-56.1	-456.2	8.55	-14.64	0.37	2.5	1.4
2800	-62.6	-469.5	7.63	-15.56	0.36	2.6	1.4
2900	-69.6	-482.2	6.72	-16.47	0.35	2.6	1.4
3000	-76.7	-494.9	5.85	-17.34	0.35	2.7	1.4

Typical S-Parameters at T_{case} = 25°C

HAMP-4002 Supply Voltage = 15 V, V_{gc} = 5 V

Frequency (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.	Mag.	Ang.
2	0.15	273	6.42	59	0.004	34	0.11	288
5	0.06	300	7.14	24	0.005	18	0.09	350
10	0.04	326	7.34	11	0.005	9	0.11	357
50	0.04	347	7.47	354	0.005	3	0.12	353
100	0.04	341	7.48	345	0.005	5	0.12	345
200	0.04	327	7.44	328	0.005	4	0.13	332
300	0.05	314	7.43	310	0.005	5	0.14	318
400	0.06	301	7.41	293	0.005	6	0.15	308
500	0.07	290	7.40	276	0.006	6	0.17	299
600	0.08	280	7.38	259	0.006	7	0.18	291
700	0.09	270	7.37	242	0.006	6	0.20	283
800	0.10	261	7.33	224	0.007	6	0.21	277
900	0.11	251	7.31	206	0.007	5	0.22	269
1000	0.12	241	7.26	189	0.007	3	0.23	262
1100	0.13	230	7.17	171	0.008	1	0.24	255
1200	0.14	219	7.08	154	0.009	358	0.25	248
1300	0.16	208	6.92	136	0.009	355	0.26	241
1400	0.17	195	6.76	118	0.010	352	0.27	233
1500	0.19	183	6.55	100	0.011	348	0.27	225
1600	0.21	171	6.31	82	0.011	343	0.28	218
1700	0.23	158	6.03	64	0.012	339	0.28	211
1800	0.25	146	5.72	47	0.013	334	0.28	203
1900	0.28	134	5.38	29	0.013	329	0.28	196
2000	0.30	122	5.04	12	0.014	324	0.28	190
2100	0.32	111	4.69	355	0.015	318	0.27	183
2200	0.34	99	4.32	338	0.015	312	0.27	176
2300	0.36	89	3.97	322	0.016	306	0.25	170
2400	0.38	82	3.66	309	0.016	302	0.24	166
2500	0.39	74	3.34	296	0.017	297	0.23	160
2600	0.41	65	3.02	281	0.017	291	0.21	153
2700	0.42	56	2.73	266	0.017	286	0.20	145
2800	0.43	48	2.45	252	0.017	279	0.19	137
2900	0.44	41	2.20	239	0.017	273	0.18	129
3000	0.46	34	1.98	226	0.017	267	0.18	120

Typical Performance Parameters at T_{case} = 25°C

HAMP-4002 V_{gc} = 5 V

Frequency (MHz)	Linear Phase Dev. (Deg.)	Rel. Phase (Deg.)	Gain Absolute (dB)	Gain Dev. (dB)	Group Delay (ns)	In VSWR	Out VSWR
2	-56.1	74.3	16.16	-1.32	107.61	1.4	1.2
5	-21.9	39.7	17.08	-0.40	14.21	1.1	1.2
10	-9.9	26.7	17.32	-0.16	4.51	1.1	1.2
50	0.20	9.7	17.47	-0.01	0.62	1.1	1.3
100	0.13	0.0	17.48	0.00	0.49	1.1	1.3
200	0.36	-16.7	17.43	-0.05	0.48	1.1	1.3
300	0.46	-34.3	17.42	-0.06	0.48	1.1	1.3
400	0.06	-51.3	17.40	-0.08	0.47	1.1	1.4
500	-0.4	-68.4	17.38	-0.10	0.47	1.1	1.4
600	-0.6	-85.7	17.36	-0.12	0.48	1.2	1.4
700	-0.7	-103.0	17.35	-0.13	0.48	1.2	1.5
800	-0.9	-120.3	17.31	-0.18	0.49	1.2	1.5
900	-0.4	-138.2	17.28	-0.21	0.49	1.2	1.6
1000	-0.4	-155.7	17.21	-0.27	0.49	1.3	1.6
1100	-0.5	-173.1	17.11	-0.37	0.49	1.3	1.6
1200	-0.2	-190.9	17.00	-0.48	0.50	1.3	1.7
1300	0.3	-208.8	16.80	-0.68	0.50	1.4	1.7
1400	0.6	-226.7	16.60	-0.88	0.50	1.4	1.7
1500	1.2	-244.6	16.33	-1.15	0.50	1.5	1.8
1600	1.5	-262.4	16.00	-1.48	0.50	1.5	1.8
1700	1.9	-280.3	15.60	-1.87	0.49	1.6	1.8
1800	2.1	-298.0	15.15	-2.33	0.49	1.7	1.8
1900	2.1	-315.5	14.62	-2.85	0.48	1.8	1.8
2000	1.9	-332.8	14.05	-3.42	0.47	1.9	1.8
2100	1.3	-349.6	13.42	-4.05	0.47	1.9	1.8
2200	0.5	-366.3	12.72	-4.75	0.46	2.0	1.7
2300	-0.8	-382.5	11.98	-5.49	0.40	2.1	1.7
2400	-5.7	-395.0	11.27	-6.20	0.36	2.2	1.6
2500	-9.7	-408.5	10.47	-6.99	0.40	2.3	1.6
2600	-12.2	-423.5	9.61	-7.85	0.41	2.4	1.5
2700	-15.1	-438.0	8.71	-8.75	0.40	2.4	1.5
2800	-18.5	-452.1	7.79	-9.66	0.38	2.5	1.5
2900	-22.5	-465.6	6.86	-10.59	0.37	2.6	1.5
3000	-26.7	-478.9	5.94	-11.51	0.37	2.7	1.4

High Reliability Amplifier Products

HAMP-4001TXV
HAMP-4002TXV

Since the advantages of products tested to well established reliability screening standards can be of significant value to reliability oriented customers, HP makes available products with Hi-Rel screening and testing patterned after MIL-STD-883, Method 5004 latest revision.

The table below depicts the screening program for this family of amplifiers.

100% SCREENING PROGRAM

Screening Test/Inspection	MIL-STD-883 Test Method	Conditions/Comments
1. Internal Visual Inspection (PreCap)	2017	
2. High Temperature Storage (Stabilization Bake)	1008	Condition B T = 125°C, t = 24 hours
3. Temperature Cycling	1010	Condition B -55°C to 125°C
4. Constant Acceleration	2001	Condition B 20 kg's, Y_1 Direction
5. Hermeticity Tests (Fine and Gross)	1014	Conditions A and C
6. Pre Burn-in Electrical	—	Per Applicable Device Specification
7. Burn-in	1015	t = 168 hours T_A = 25°C and 80% of Rated Bias Conditions
8. Post Burn-in Electrical (PDA ≤10%)	—	Per Applicable Device Specification
9. Final Electrical Tests	—	Per Applicable Device Specification
10. External Visual Inspection	2009	

Note: Additional tests, screens and qualification testings (e.g.: X-ray, PIND, Extended Burn-in, and Lot qualification) are available on request.

Ordering Information

Add suffix TXV to standard part number.

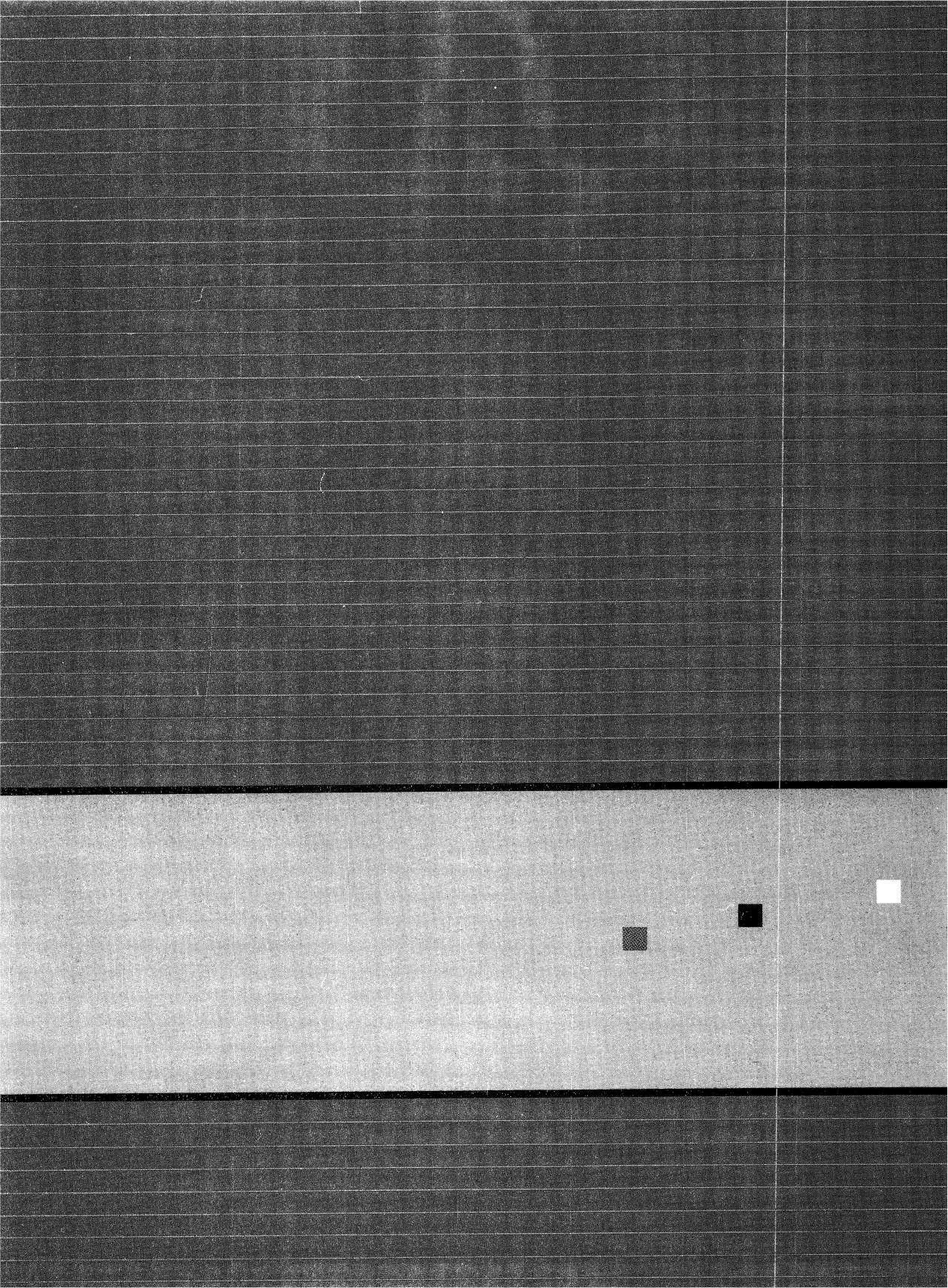
Example: Standard Product HAMP-4001, HAMP-4002
Hi-Rel Product HAMP-4001TXV, HAMP-4002TXV

ABSTRACTS OF APPLICATION NOTES FOR AMPLIFIERS

The Microwave Semiconductor Division field sales force is supported by a division applications staff. These technical specialists investigate circuit applications of most interest to the users of these semiconductor devices. The results of these investigations are reported in application notes or in brief application bulletins.

A complete list with brief abstracts is presented here. Below is a brief summary of Application Notes for Amplifiers. All of the Application Notes are available from your local HP Sales Office or nearest HP Components Authorized Distributor or Representative.

AN 996 Designing with HAMP-1001, 1002, 1003 and 1004 TO-8 Amplifiers
The four amplifiers discussed in this applications note are cascadable gain block amplifiers housed in TO-8 packages with guaranteed RF specifications across the entire 10 to 1500 MHz band. Maximum input and output VSWR is 2:1 into 50 ohms. Included in the note is RF data for both single stages and cascades of 2, 3 and 4 stages of TO-8 amplifiers. Printed circuit board artwork for single stage amplifiers and cascades of up to four TO-8 amplifiers are also included.



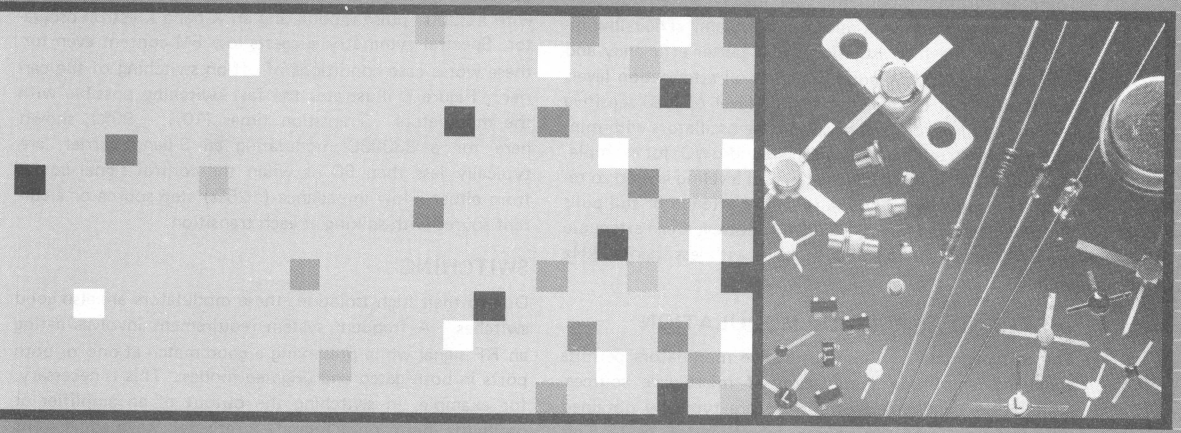
Switches, Switch Drivers and Modulators

Switches and Switch Driver

- SPDT General Purpose Microwave Switch
  0.1-18 GHz 10-8
- SPST General Purpose Microwave Switches
  Broadband 0.1-18 GHz,
  Broadband Modules DC-18 GHz 10-10
- SPST Low Loss Microwave Switches
  DC-18 GHz 10-16
- SPST Fast Microwave Switches
  DC-18 GHz 10-20
- Switch Driver for Fast SPST PIN Diode
  Switches 10-24

Absorptive Modulators

- 1-18 GHz 10-2
- Reliability Data 10-26



HEWLETT PACKARD

ABSORPTIVE MODULATORS 1-18 GHz

33000 C/D
33001 C/D
33008 C/D

Features

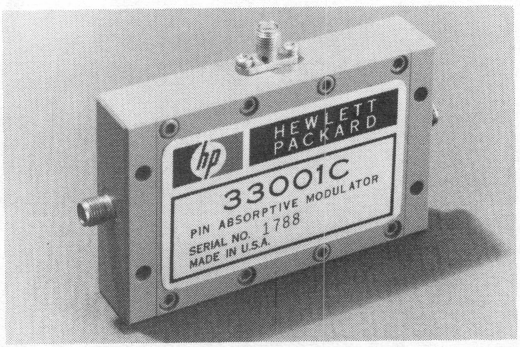
MATCHED AT ALL ATTENUATION LEVELS

HANDLES 2 WATTS AVERAGE, 100 WATTS PEAK

COVERS GREATER-THAN-OCTAVE BANDS

LOW INSERTION LOSS/HIGH ISOLATION

SMALL, LIGHT, RUGGED



Description

These Absorptive Modulators are electronically controllable attenuators for the frequency range from 1 to 18 GHz. Each product covers greater than one octave and presents a good impedance match ($Z_O = 50\Omega$) at both RF ports for all values of attenuation.

The diagrams in Figure 1 show the configurations of the modulators. Good environmental characteristics are provided by hermetically sealed semiconductor devices and a rugged overall package. They are also small and lightweight and hence they are well suited for either airborne or portable microwave systems.

Applications

LEVEL SETTING

These Absorptive Modulators are ideally suited for controlling signal levels in a microwave system. Their low insertion loss and high isolation mean better efficiency and dynamic range. Their good match at all attenuation levels means they can control the output level of load sensitive klystron, backward wave, or solid state oscillators with minimal frequency pulling. A typical X-band BWO, for example, will pull 70 MHz at 10 GHz when grid leveling is used to reduce its output by 10 dB. A reflective attenuator still pulls the BWO almost 1 MHz. A 33001D, however, can attenuate the BWO output over an 80 dB range with less than 50 kHz pulling.

WIDEBAND AMPLITUDE MODULATION

The fast response of these absorptive modulators permits wideband amplitude modulation of microwave sources. Modulation bandwidths of 2 MHz are typically obtained driving from a resistive source impedance of 25Ω. This bandwidth can be extended beyond 5 MHz with a simple peaking or pre-emphasis network. Typically, millivolt signals are all that are required to achieve a modulation index of 20%. At these modulation levels, total harmonic distortion is typically less than 5%. In addition, the absorptive modulator's low reflection coefficient means that load sensitive sources can be amplitude modulated without introducing significant incidental frequency or phase modulation. Figure 2 shows a 10 GHz carrier from a mechanically tuned klystron oscillator with 1 MHz sidebands introduced by a 33001D. Attenuation at the carrier is less than 6 dB and the modulation index is 20%. Note that the undesired 2 MHz components are greater than 25 dB down. Also note the symmetry of the spectrum, suggesting low incidental fm.

PULSE MODULATION

Modulation capability extends to pulse modulation where typically fast transition times and high on-off ratios are required. Figures 3 and 4 illustrate typical spectra obtained with a 33001 pulse modulating an X-band klystron oscillator. Spectral symmetry suggests low FM content even for these worse case conditions of off-on switching of the carrier. Figure 5 illustrates the fast switching possible with the modulators. Transition times (10% – 90%), shown here for a 33000C modulating an S-band carrier, are typically less than 50 ns when the control signal comes from either a low impedance (~25Ω) step source or a current source with spiking at each transition.

SWITCHING

Due to their high isolation, these modulators are also good switches. A frequent system requirement involves gating an RF signal while preserving a good match at one or both ports in both gated and ungated modes. This is necessary, for example, in switching the output of an amplifier or oscillator that cannot tolerate a reflected wave equal to its own output power. In other applications it is important to maintain 50Ω input and output impedances at both ports of the switch to keep other active functional blocks stable. The absorptive modulators are a compact solution for these applications since they are matched at both ports for all attenuations.

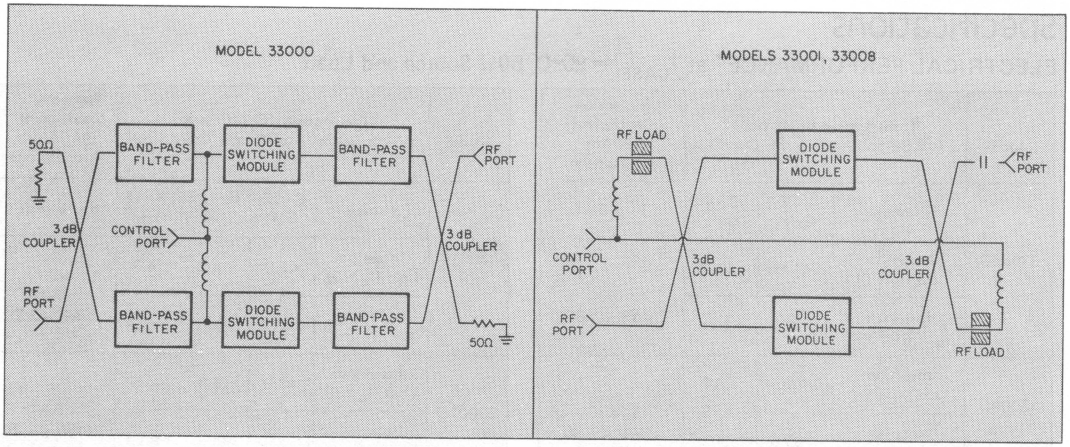


Figure 1. Absorptive Modulator Block Diagrams.

Vertical scale: 10 dB/div

Horizontal scale: 1 MHz/div

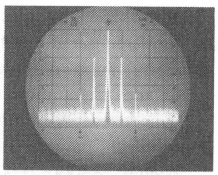


Figure 2. Spectrum of a 10 GHz carrier with 1 MHz AM sidebands produced with an HP 33001D.

Vertical scale: 10 dB/div

Horizontal scale: 3 MHz/div

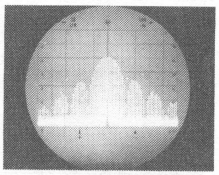


Figure 3. Spectrum of pulse modulated X-band klystron oscillator. Pulse width: 0.25 μs; repetition rate: 400 kHz.

Vertical scale: Linear (~14%/div)

Horizontal scale: 1 MHz/div

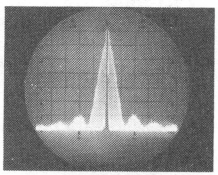


Figure 4. Spectrum of X-band klystron oscillator with pulse width: 0.75 μs; repetition rate: 6.3 kHz.

Verticle scale: 100 mV/div

Horizontal scale: 20 ns/div

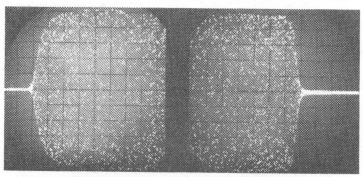


Figure 5. Time domain presentation of S-band carrier modulated using a 33000C.

Maximum Ratings

Storage Temperature: -65°C to +95°C.

Operating Temperature: -54°C to +95°C.

Maximum Incident RF Power:

CW: 2 watts, derate linearly above 25°C to 1 watt at 100°C.

Pulse (1μs wide, 0.001 duty cycle): 100 watts, derate linearly above 25°C to 50 watts at 100°C.

Maximum Negative Control Current: 200mA, C models; 400mA, D models.

Maximum Voltage, Control Port: +50 volts.

Specifications

ELECTRICAL PERFORMANCE* at T_{CASE} = 25°C, 50Ω Source and Load

Model	Transmission Coefficient (dB Below Unity Trans. Coeff.)			Reflection Coefficient (At Any Attenuation)
	Parameter	1 - 2 GHz	2 - 4 GHz	1 - 4 GHz
33000C	Insertion Loss (I_C = 0)	<1.8	<2.5	<0.30 (SWR <1.86)
	Isolation (I_C=–100 mA)	>35.0	>40.0	
33000D	Insertion Loss (I_C = 0)	<2.0	<3.0	<0.30 (SWR <1.86)
	Isolation (I_C=–400 mA)	>65.0	>80.0	

Model	Transmission Coefficient (dB Below Unity Trans. Coeff.)				Reflection Coefficient (At Any Attenuation)
	Parameter	8 - 12 GHz	12 - 15 GHz	15 - 18 GHz	8 - 18 GHz
33001C	Insertion Loss (I_C = 0)	<3.0	<3.2	<4.3	<0.375 (SWR <2.2)
	Isolation (I_C=–75 mA)	>43.0	>43.0	>43.0	
33001D	Insertion Loss (I_C = 0)	<3.0	<3.5	<4.5	<0.375 (SWR <2.2)
	Isolation (I_C=–75 mA)	>80.0	>80.0	>80.0	

Model	Transmission Coefficient (dB Below Unity Trans. Coeff.)		Reflection Coefficient (At Any Attenuation)	
	Parameter	3.7 - 8.0 GHz	3.7 - 7.0 GHz	7.0 - 8.0 GHz
33008C	Insertion Loss (I_C = 0)	<2.3	<0.33 (SWR <2.00)	<0.375 (SWR <2.2)
	Isolation (I_C=–100 mA)	>45.0		
33008D	Insertion Loss (I_C = 0)	<2.5	<0.33 (SWR <2.00)	<0.375 (SWR <2.2)
	Isolation (I_C=–200 mA)	>80.0		

Control Current Polarity: Negative

Switching Time: Typically less than 50 ns.

Noise Figure: Noise figure is approximately equal to attenuation at any control current.

Distortion: Harmonics are typically at least 40 dB below fundamental at input power levels up to 2 watts.

Stability: Attenuation typically resets to within 5% (i.e. 5% of the attenuation in dB) for a given control current over extended time periods and temperature cycles.

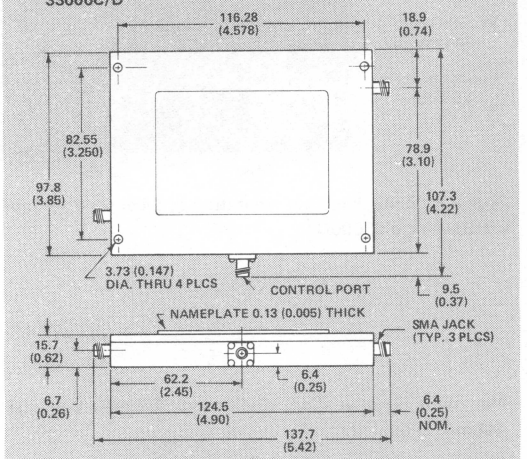
Mechanical Characteristics:

Weight: 33000, 0.50 kg (1.10 lbs)
33001, 0.185 kg (0.41 lbs)
33008, 0.334 kg (0.74 lbs)

*Test data or selected electrical specials are available at additional cost. Contact your local HP Sales Office.

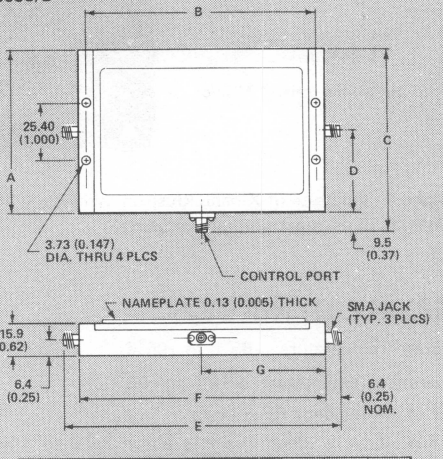
Outline Drawings

33000C/D



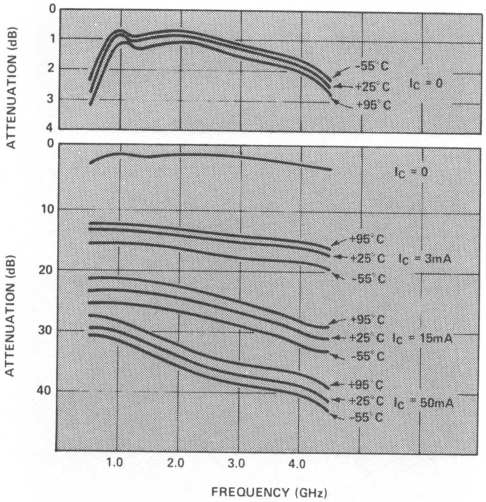
DIMENSIONS IN MILLIMETERS AND (INCHES).
TOLERANCES UNLESS OTHERWISE SPECIFIED:
X.X = 0.5 (0.020) X.XX = 0.13 (0.005).

33001C/D
33008C/D

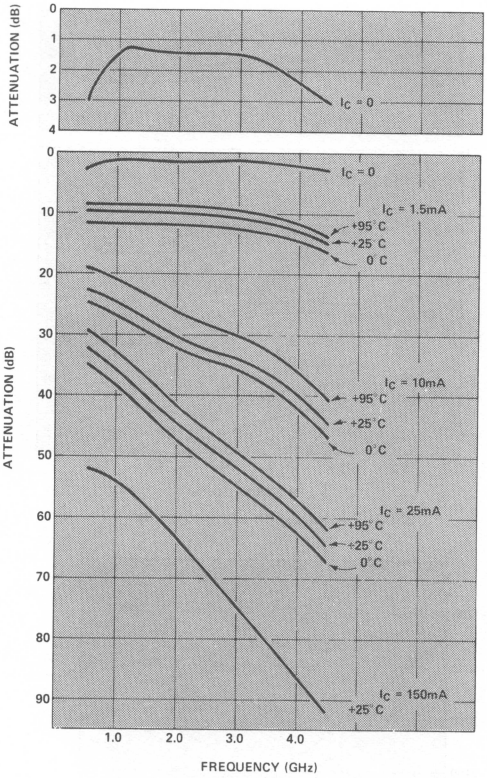


	A	B	C	D	E	F	G
33001C/D	50.8 (2.00)	73.03 (2.875)	60.3 (2.37)	25.4 (1.00	94.0 (3.70)	81.3 (3.20)	40.6 (1.60)
33008C/D	66.7 (2.62)	101.60 (4.000)	76.2 (3.00)	33.3 (1.31)	127.0 (5.00)	114.3 (4.50)	57.2 (2.25)

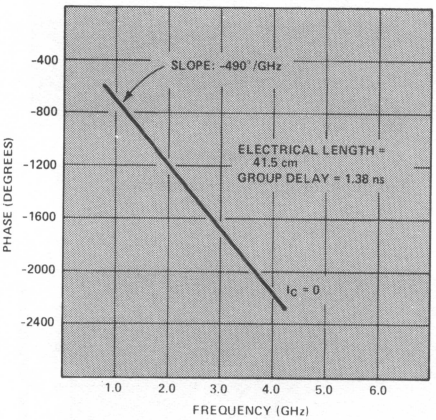
Typical Performance 33000 C/D



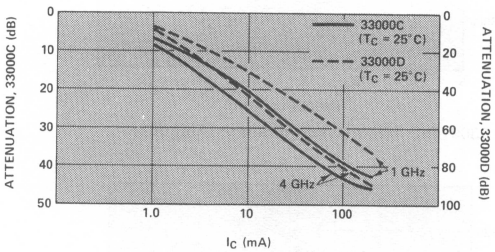
33000C Attenuation vs. Frequency



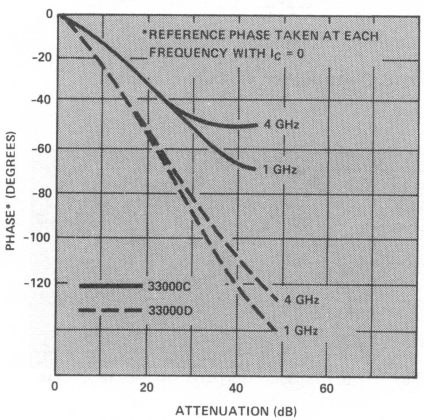
33000D Attenuation vs. Frequency



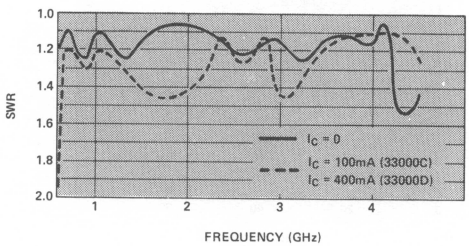
33000C/D Transmission Phase vs. Frequency



33000C/D Attenuation vs. Control Current

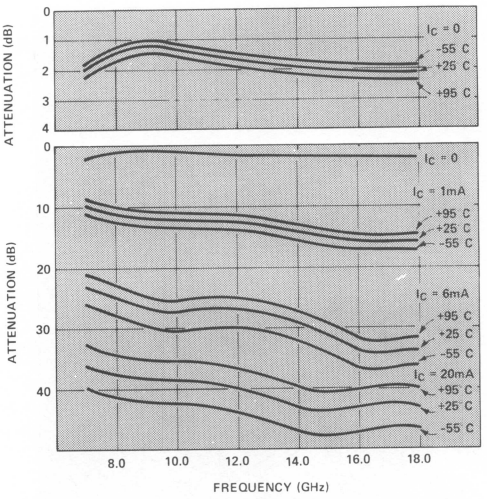


33000C/D Transmission Phase vs. Attenuation

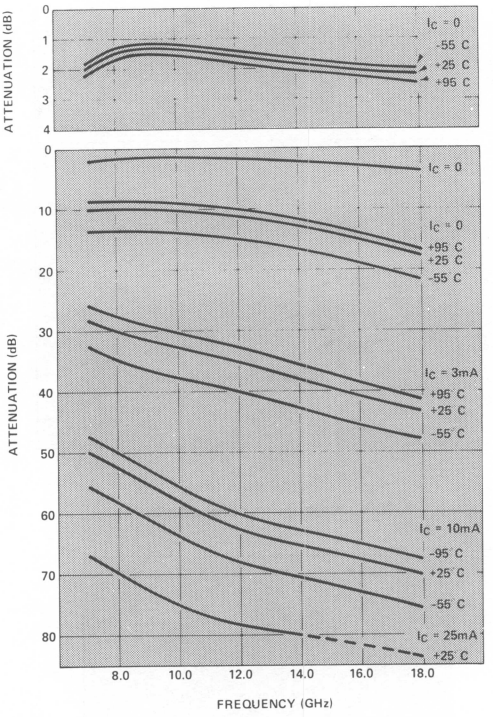


33000C/D SWR vs. Frequency

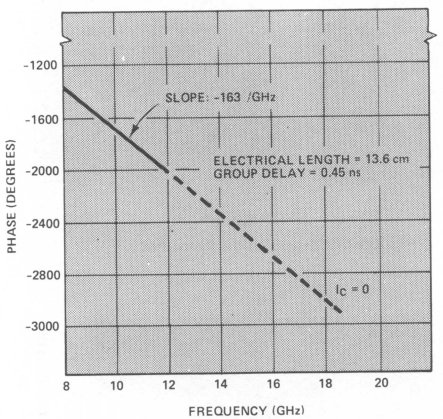
Typical Performance 33001 C/D



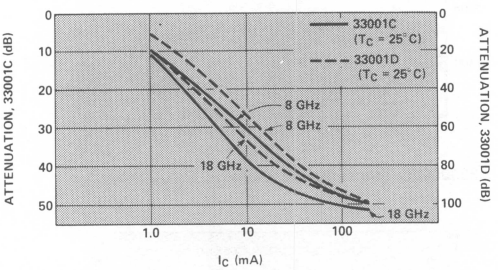
33001C Attenuation vs. Frequency



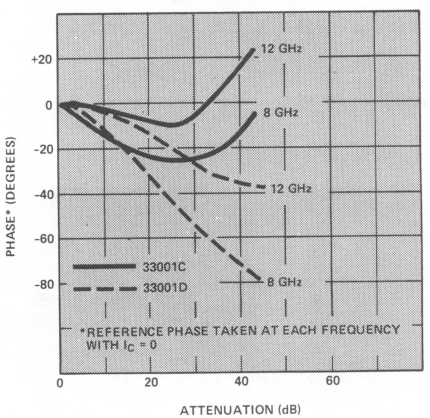
33001D Attenuation vs. Frequency



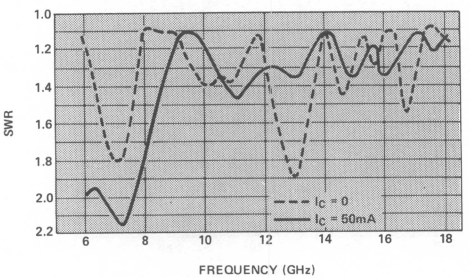
33001C/D Transmission Phase vs. Frequency



33001C/D Attenuation vs. Control Current

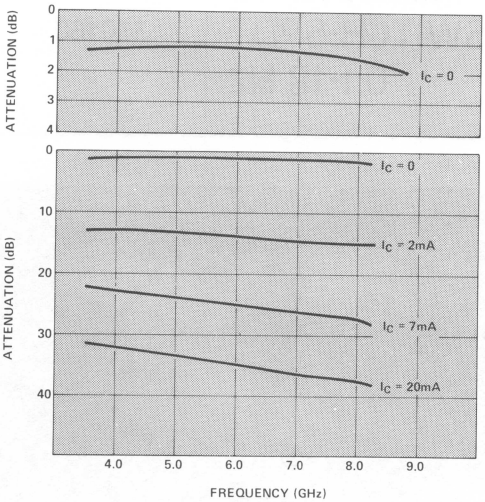


33001C/D Transmission Phase vs. Attenuation

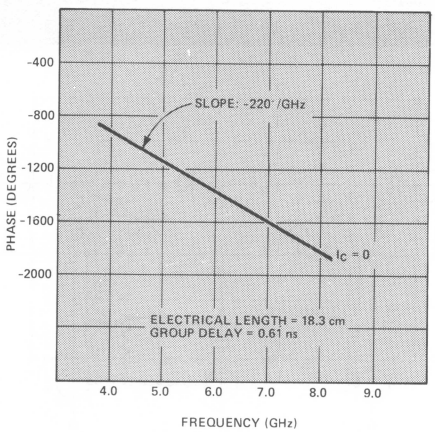


33001C/D SWR vs. Frequency

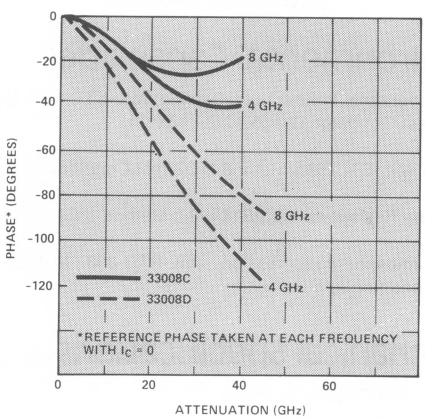
Typical Performance 33008 C/D



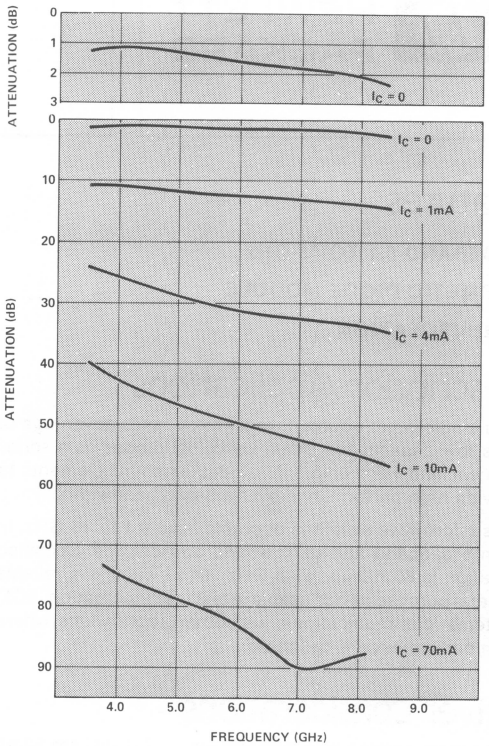
33008C Attenuation vs. Frequency



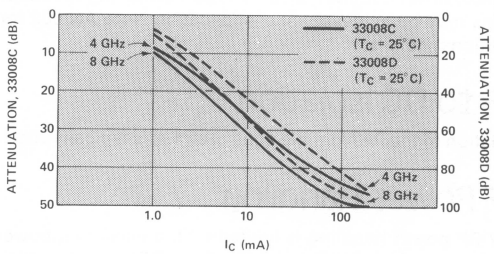
33008C/D Transmission Phase vs. Frequency



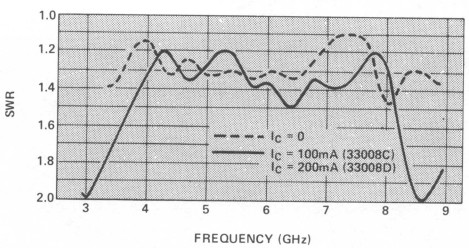
33008C/D Transmission Phase vs. Attenuation



33008D Attenuation vs. Frequency



33008C/D Attenuation vs. Control Current



33008C/D SWR vs. Frequency

HEWLETT PACKARD

MICROWAVE SWITCH-SPDT 0.1-18 Hz

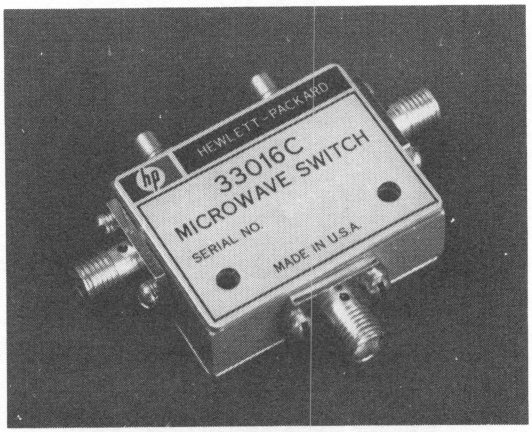
33016C

Features

WIDEBAND 0.1 TO 18 GHz

HERMETIC DIODE MODULE

HIGH ISOLATION



Description/Applications

This single-pole, double-throw switch takes advantage of HP's low capacitance Beam Lead PIN diodes as a series element and HP's chip PIN diodes as shunt elements to provide high performance over a broad bandwidth.

This microwave switch is operable from 0.1 to 18 GHz, in both broadband and narrowband applications. Specified isolation is 60 dB up to 18 GHz. This switch is a reliable general purpose device usable in test instrumentation, ECM systems, communications, and other applications where high performance is desirable.

Driver Considerations

The recommended bias currents for the 33016C are 50mA for the ON arm and -50mA for the OFF arm. Driver requirements are dictated by the specific application. Using suitable driver circuits typical 10 to 90% switching speeds of 100ns may be achieved. See Application Note AN 932 for additional details.

RF to DC Isolation

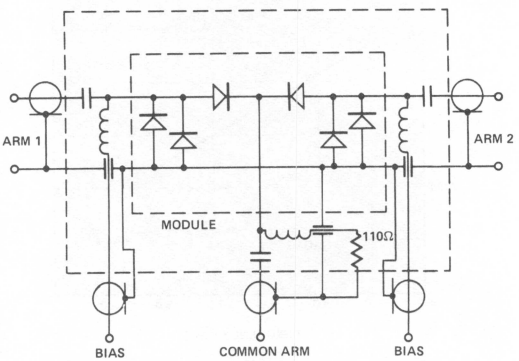
Isolation of the RF from the control circuit is typically 30dB.

RF Power Handling

CW RF power handling is limited by the maximum power dissipation of the ON series diode. Pulse RF power handling is limited by the voltage breakdown of the shunt diodes.

Maximum Ratings

Parameter	Limits
Operating Temperature	-65°C to +95°C
Storage Temperature	-65°C to +125°C
CW RF Power at T_C=25°C	1W (Derate linearly to 0.4W at 95°C)
Pulse RF Power at T_C=25°C (1μs, 0.001 duty cycle)	75W (Derate linearly to 33W at 95°C)
Control Current	+100mA (ON Arm) / -100mA (OFF Arm)
Control Voltage	-1V, +12.0V



SCHEMATIC DIAGRAM

Environmental Capabilities

Non-Operating Temperature Cycling: MIL-STD-883. Method 1010 Test Condition B (-55°C to +125°C).

Shock: MIL-STD-883. Method 2002 Test Condition B.

Moisture Resistance: MIL-STD-883. Method 1004.

Salt Atmosphere: (corrosion) MIL-STD-883. Method 1009 Test Condition A.

Mechanical Specifications

Size: See Outline Drawing.
Body Finish: painted

Electrical Specifications at T_{CASE} =25°C

Parameter*	Frequency Range (GHz)				
	0.1-1	1-2	2-4	4-12	12-18
Minimum Isolation, Common to OFF Arm (dB)	70	70	70	60	55
Maximum Insertion Loss, ON Arm (dB)	1.5	2.0	2.0	2.0	3.0
Maximum SWR, ON Arm	1.5	1.5	1.8	2.2	3.0

*I_C(OFF) = -50mA
I_C(ON) = +50mA

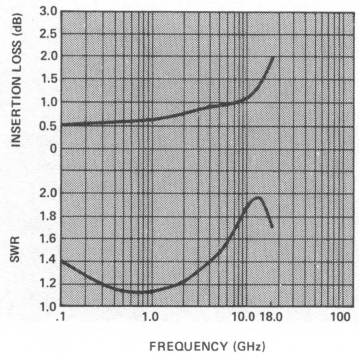


Figure 1. Typical Insertion Loss and SWR (ON Arm).

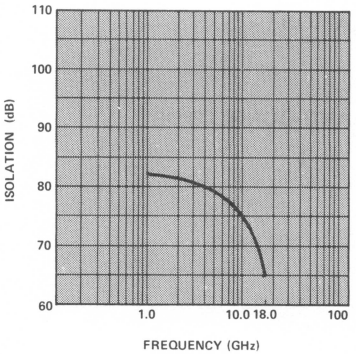
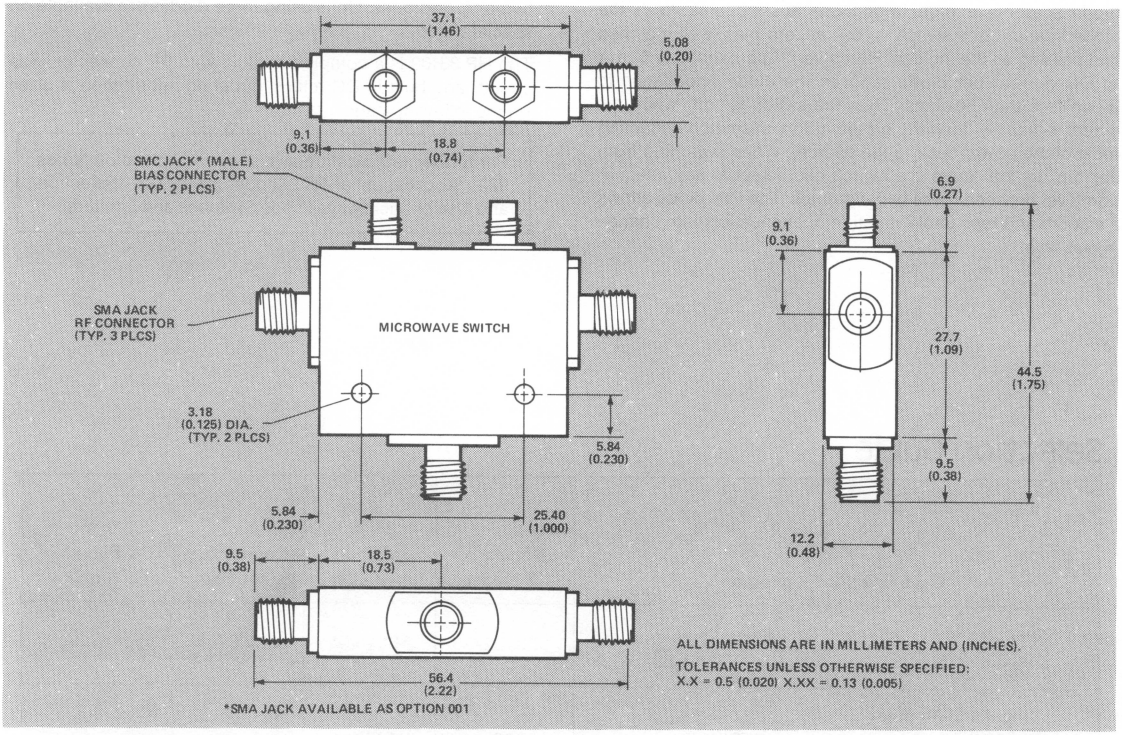


Figure 2. Typical Isolation (OFF Arm).

Outline Drawing



HEWLETT PACKARD

GENERAL PURPOSE MICROWAVE SPST SWITCHES DC-18 GHz

33102A
33104A
33602A
33604A

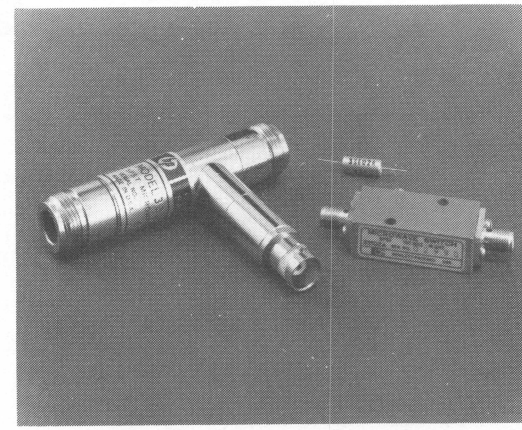
Features

LOW INSERTION LOSS

HIGH ISOLATION

LOW SWR

PACKAGE AND CONNECTOR VARIETY



Description

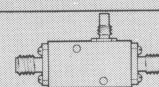
HP SPST switches utilize PIN diodes in shunt across a 50 ohm transmission line. At microwave frequencie the PIN diode presents a high impedance at zero bias. With the diode in shunt, the switch is "on" at zero bias (well matched and passing all the incident RF power). Approximately 50 mA of DC current per diode reduces the diode impedance to much less than 50 ohms. Thus the switch is "off" when the diode is heavily forward biased (high mismatch reflecting most of the power back to the source). When switching from the "on" to "off" state, the switch can be set at any attenuation level between these two extremes. The PIN diode allows a smooth and repeatable variation of attenuation with change in bias level.

The basis of the HP SPST switch product line is the 33600 series coaxial module. The modules are available with either two or four diodes. Units using three diodes are available on special order.

The HP 33100 is a complete switch, with RF connector, bias circuit, and built in DC return. Ordering information is given on the following page.

For further technical details, see HP Application Notes 922, "Application of PIN Diodes" and 932, "Selection and Use of Microwave Diode Switches and Limiters".

Selection Guide

Description/Configuration	Standard (2-diode)	High Isolation (4-diode)	Connector Options	DC Bias Circuit
Broadband 33100 Series 	33102A	33104A	SMA Only	Built-In
Broadband Modules 33600 Series 	33602A	33604A	No Connectors	None

Ordering Information

33100 Series General Purpose Switches
The 33100 series switch is a broadband general purpose switch. The standard unit is supplied with SMA jack (female) RF connectors and SMC jack bias connector. An SMA jack bias connector is available as Option 001.

33600 Series Coaxial Modules
The 33600 coaxial switch module is the basic building block for all other switch models. It is ordered by model number without option numbers.

Electrical Specifications

MAXIMUM RATINGS

Parameter	33100 Series	33600 Series
Operating Temperature	-55° C to +95° C	-65° C to +150° C
Storage Temperature	-55° C to +125° C	-65° C to +150° C
CW RF Power at T_{CASE} = 25° C	2 W (Derate to .85 W at 95° C)	See Figures 6-7
Pulse RF Power at T_{CASE} = 25° C (1 μs 0.001 duty cycle)	75 W (Derate to 33 W at 95° C)	
Control Current/Voltage	See Following Table	

MAXIMUM CONTROL CURRENT/VOLTAGE

Model	Current (mA)	Voltage (V)
33102, 33602	-200	+100 to -1.0
33104, 33604	-400	+100 to -1.0

NOISE FIGURE
Equal to attenuation.

DISTORTION
Internally generated harmonics in the General Purpose Series are typically 40 dB below the fundamental at input power levels up to 2 watts.

RF TO DC ISOLATION
Isolation of the RF from the control circuit is typically 30 dB.

DRIVER CONSIDERATIONS
Driver requirements are dictated by the specific application. When the switch is used as a modulator or attenuator, a current amplifier is required. Suitable integrated circuits can be obtained for either laboratory or OEM applications. For example, an HP 33190B is suitable as a driver.

SWITCH SCHEMATICS



Figure 1. Module Schematic

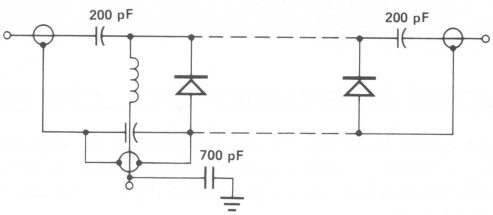


Figure 2. Switch Assembly Schematic

Model	Diode Polarity	Number Of Diodes
33102, 33602	As Shown	2
33104, 33604	As Shown	4

Typical Switching Speed (10%-90%)	General Purpose
	33102A, 33104A, 33602A, 33604A
Off-On	50 ns
On-Off	50 ns

Electrical Specifications at $T_{CASE}=25°C$

33100 SERIES BROADBAND

Model	Parameter	Conditions	Frequency Range (GHz)					
			0.1-1.0	1.0-2.0	2.0-4.0	4.0-8.0	8.0-12.0	12.0-18.0
33102A	Minimum Isolation (dB)	I_C=-100mA	33	35	40	43	43	43
	Maximum Insertion Loss (dB)	I_C=0	1.0	1.0	1.3	2.0	2.0	2.5
	Maximum SWR		1.7	1.7	1.8	2.0	2.0	2.5
33104A	Minimum Isolation (dB)	I_C=-200mA	42	65	80	80	80	—
	Maximum Insertion Loss (dB)	I_C=0	1.0	1.0	1.5	2.1	2.2	—
	Maximum SWR		1.7	1.8	2.0	2.0	2.0	—

33600 SERIES BROADBAND MODULES

Model	Parameter	Conditions	Frequency Range (GHz)						
			DC-0.1	0.1-1.0	1.0-2.0	2.0-4.0	4.0-8.0	8.0-12.0	12.0-18.0
33602A	Minimum Isolation (dB)	I_C=-100mA	30	33	35	40	43	43	43
	Maximum Insertion Loss (dB)	I_C=0	0.2	0.5	0.5	0.7	1.2	1.5	2.0
	Maximum SWR		1.5	1.5	1.5	1.5	2.0	2.0	2.0
33604A	Minimum Isolation (dB)	I_C=-200mA	40	42	65	80	80	80	—
	Maximum Insertion Loss (dB)	I_C=0	0.3	0.4	0.8	1.0	1.3	1.5	—
	Maximum SWR		1.5	1.5	1.6	1.7	1.7	1.7	—

Typical Attenuation Characteristics

These curves show typical characteristics of the modules only (i.e. 33600), but the characteristics are similar for 33100 series models having the same last two digits as the 33600 module shown.

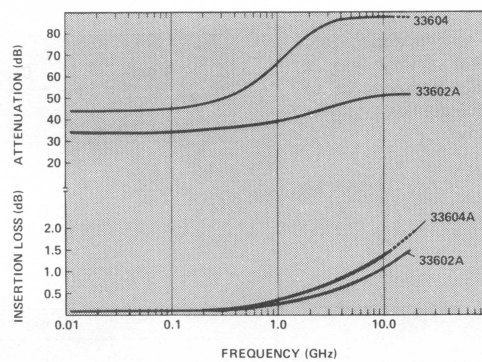


Figure 3. Attenuation and Insertion Loss vs. Frequency, 33600 Series.

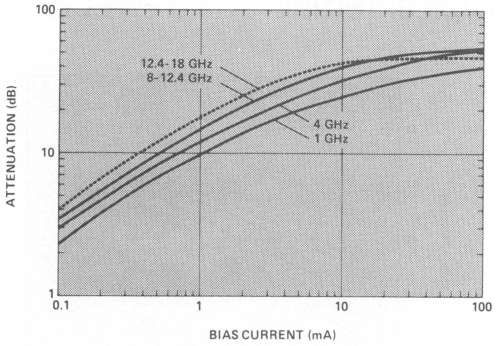


Figure 4. Attenuation vs. Bias with Frequency as a Parameter, 33602A.

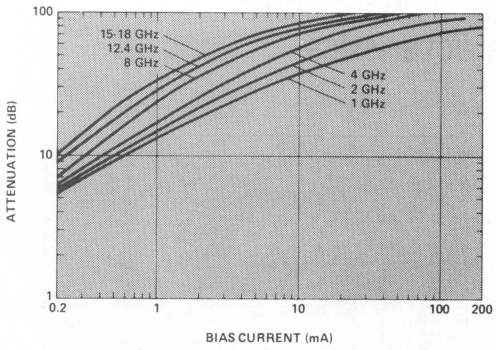


Figure 5. Attenuation vs. Bias with Frequency as a Parameter, 33604A.

RF Power Handling

The breakdown voltage of the diode, the maximum diode power dissipation, the bias state and the frequency of the RF signal all determine the maximum RF power a switch can handle. Under full isolation conditions, the limiting factor which defines power handling capability is energy storage capacity of the diodes. Under insertion loss conditions the limiting factor which defines power handling capability is diode breakdown voltage.

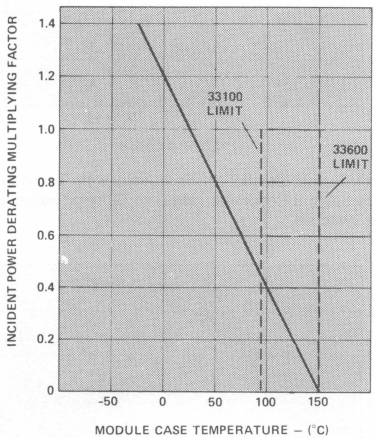


Figure 6. Temperature Derating of Incident Power

RF Power Handling at $T_{CASE} = 25°C$

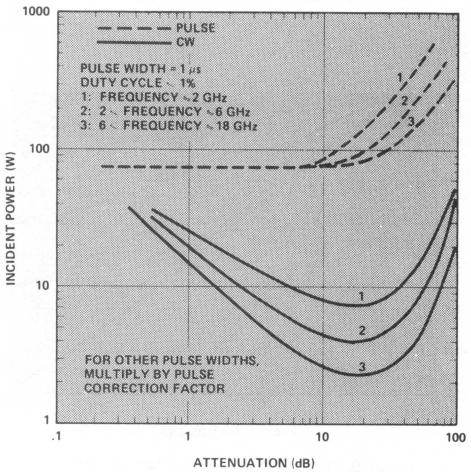


Figure 7. Incident Pulse and CW Power Ratings vs. Attenuation, General Purpose 4-diode Switches. See Table for Pulse Correction Factor.

PULSE WIDTH CORRECTION FACTOR

Apply to Incident Power Ratings of Figure 7.

Pulse Width	Correction Factor
0.5 μs	1.55
2.0 μs	0.62

Typical Phase Shift Characteristics

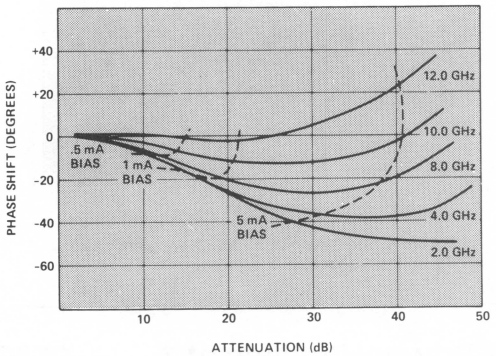


Figure 8. Phase Shift vs. Attenuation, 33602A.

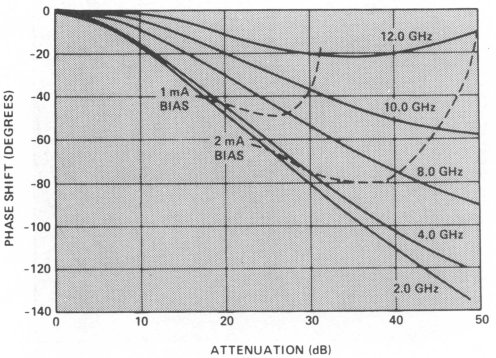


Figure 9. Phase Shift vs. Attenuation, 33604A.

The phase shift characteristics of the switches are a function of frequency and the electrical length at a specific bias. The air equivalent electrical lengths for the two principal bias conditions are:

Switch State	33602A	33604A
ON	1.8 cm	2.3 cm
	Between reference planes of the module.	
OFF	0.7 cm	0.7 cm
	Between either reference plane of the module and the internal short.	

Typical Temperature Effects

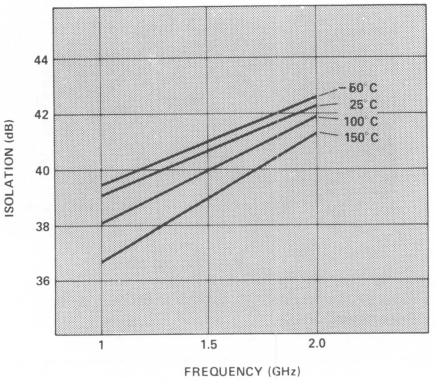


Figure 10. Typical Isolation vs. Frequency with Temperature as a Parameter at Recommended Bias, General Purpose 2-diode Switches.

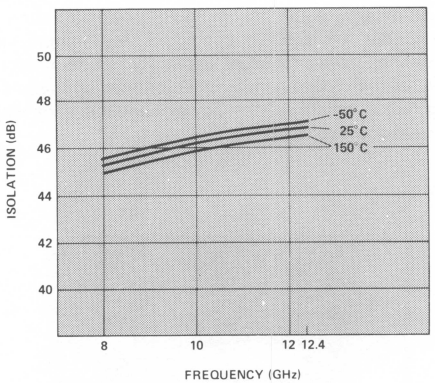


Figure 11. Typical Isolation vs. Frequency with Temperature as a Parameter at Recommended Bias, General Purpose 2-diode Switches.

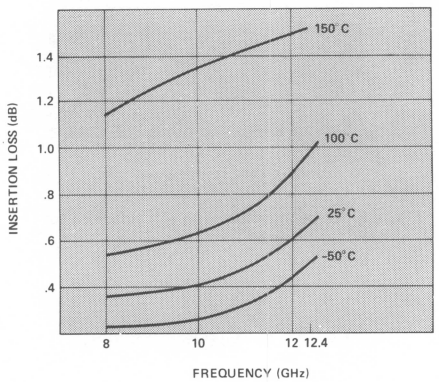


Figure 12. Typical Insertion Loss vs. Frequency with Temperature as a parameter at I_C = 0, General Purpose 2-diode Switches.

Environmental Capabilities

33100 Series:

Non-Operating Temperature Cycling: MIL-STD-883. Method 1010 Test Condition B (-55° C to +125° C).

Shock: MIL-STD-883. Method 2002 Test Condition B.

Moisture Resistance: MIL-STD-883. Method 1004.

Salt Atmosphere: (corrosion) MIL-STD-883. Method 1009 Test Condition A.

33600 Series:

Non-Operating Temperature: -65° C to +150° C.

Operating Temperature: -65° C to +150° C.

Temperature Cycling: MIL-STD-750. Method 1051, Test Condition B.

Thermal Shock: MIL-STD-750. Method 1056, Test Condition A.

Humidity: MIL-STD-750. Method 1021, omit initial conditioning.

Shock: MIL-STD-750. Method 2016, 5 blows each X_1, Y_1, Y_2, Z orientations, 0.5 msec pulse, 1500 G min., non-operating.

Vibration: MIL-STD-750. Method 2056.

Constant Acceleration: MIL-STD-750. Method 2006, 2000G.

Mechanical Specifications

Size: See Outline Drawings.

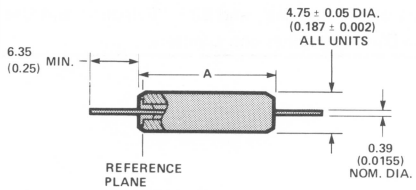
Finish: 33100 Series — Body: painted.

33600 Series — Gold plated (50 μ inches minimum).

Maximum Weight	33100 Series		33600 Series
	33102A	33104A	All
Ounces	0.8	1.0	0.07
Grams	23	29	2

Outline Drawings

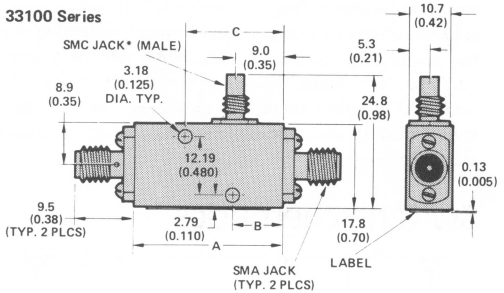
33600 Series



DIMENSIONS IN MILLIMETERS (INCHES).

Models	A
33602	10.92 ± 0.20 (0.430 ± 0.008)
33604	16.51 ± 0.20 (0.650 ± 0.008)

33100 Series



Model	A	B	C
33102	31.8 (1.25)	9.7 ± 0.25 (0.383 ± 0.010)	21.9 ± 0.25 (0.863 ± 0.010)
33104	37.3 (1.47)	12.5 ± 0.25 (0.493 ± 0.010)	24.7 ± 0.25 (0.973 ± 0.010)

*SMA Jack available as Option 001.

HEWLETT PACKARD

LOW LOSS MICROWAVE SPST SWITCHES DC-18 GHz

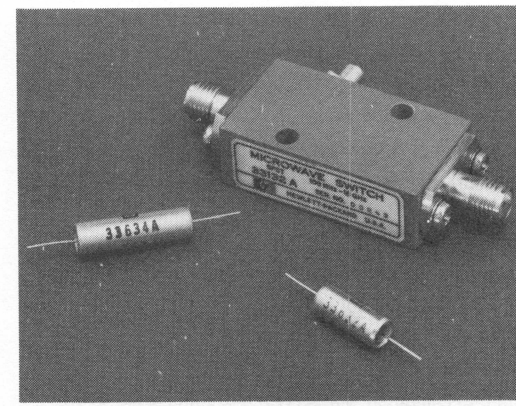
33132A
33134A
33632A
33634A

Features

LOW INSERTION LOSS

HIGH ISOLATION

LOW SWR



Description

HP SPST switches utilize PIN diodes in shunt across a 50Ω transmission line. At microwave frequencies the PIN diode presents a very high impedance at zero bias. With the diode in shunt, the switch is "on" at zero bias (well matched and passing all the incident RF power). Approximately 15mA of DC current per diode reduces the diode impedance to much less than 50 ohms. Thus the switch is "off" when the diode is heavily forward biased (high mismatch reflecting most of the power back to the source). When switching from the "on" to "off" state, the switch can be set at any attenuation level between these two extremes. The PIN diode allows a smooth and repeatable variation of attenuation with change in bias level.

The basis of the HP SPST switch product line is the coaxial module. The 33600 series module is optimized for low insertion loss with high isolation. The modules are available with either two or four diodes. Units using three diodes are available on special order.

The HP 33130 series are complete switches, with RF connector, bias circuits, and built-in DC returns.

For further technical details, see HP Application Notes 922, "Applications of PIN Diodes" and 932, "Selection and Use of Microwave Diode Switches and Limiters".

Switch Schematics

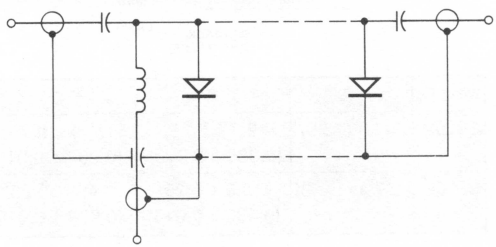


Figure 1. Switch Assembly Schematic. 33130 Series.

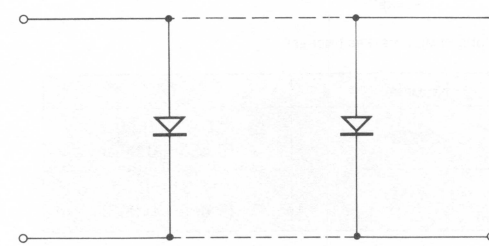


Figure 2. Module Schematic. 33630 Series.

Model	Diode Polarity	Number Of Diodes
33132A, 33632A	As Shown	2
33134A, 33634A	As Shown	4

Electrical Specifications

MAXIMUM RATINGS

Parameter	33130 Series	33630 Series
Operating Temperature	-55°C to +95°C	-65°C to +150°C
Storage Temperature	-55°C to +125°C	-65°C to +150°C
CW RF Power at T_C = 25°C	2W (Derate linearly to .85W at 95°C)	2W (Derate linearly to zero at 150°C)
Pulse RF Power at T_C = 25°C (1 μs, 0.001 duty cycle)	75W (Derate linearly to 33W at 95°C)	75W (Derate linearly to zero at 150°C)
Control Current/Voltage	See Following Table	

MAXIMUM CONTROL CURRENT/VOLTAGE

Model	Current (mA)	Voltage (V)
33132A, 33632A, 33134A, 33634A	+200 +400	-100 to +1 -100 to +1

RF POWER HANDLING

The breakdown voltage of the diode, the maximum diode power dissipation, the bias state and the frequency of the RF signal all determine the maximum RF power a switch can handle.

PULSE WIDTH CORRECTION FACTOR

Apply to Incident Power Ratings of Figure 3.

Pulse Width	Correction Factor
0.5 μs	1.55
2.0 μs	0.62

DRIVER CONSIDERATIONS

Driver requirements are dictated by the specific application. When the switch is used as a modulator or attenuator, a current amplifier is required. Suitable integrated circuits can be obtained for either laboratory or OEM applications. The HP 33190B is also suitable as a driver. Typical 10%-90% switching speed is 50 to 100 ns in either off-on or on-off switching.

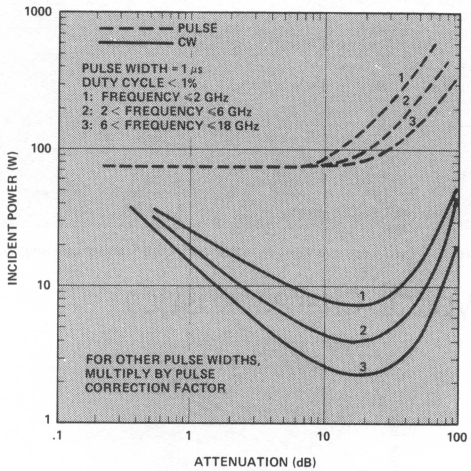


Figure 3. Incident Pulse and CW Power Ratings vs. Attenuation. See Table for Pulse Correction Factor. (T_C = 25°C)

NOISE FIGURE

Equal to attenuation.

DISTORTION

Internally generated harmonics are typically 40 dB below the fundamental at input power levels up to 2 watts.

RF TO DC ISOLATION

Isolation of the RF from the control circuit is typically 30 dB.

Electrical Specifications at $T_{CASE}=25°C$

33130 SERIES SWITCHES

Model	Parameter	Conditions	Frequency Range (GHz)					
			.1-1.0	1.0-2.0	2.0-4.0	4.0-8.0	8.0-12.0	12.0-18.0
33132A	Minimum Isolation (dB)[1]	I_C=30mA	28	33	37	43	43	43
	Maximum Insertion Loss (dB)	V_C=-10V	1.0	1.0	1.0	1.2	1.4	2.0
	Maximum SWR		1.7	1.7	1.7	1.9	1.9	2.2
33134A	Minimum Isolation (dB)[1]	I_C=200mA	40	60	80	80	80	80
	Maximum Insertion Loss (dB)	V_C=-10V	1.0	1.0	1.4	1.6	1.8	2.5
	Maximum SWR		1.7	1.7	2.0	2.0	2.0	2.2

33630 SERIES MODULES

Model	Parameter	Conditions	Frequency Range (GHz)						
			DC-0.1	0.1-1.0	1.0-2.0	2.0-4.0	4.0-8.0	8.0-12.0	12.0-18.0
33632A	Minimum Isolation (dB)[1]	I_C=30mA	28	28	33	37	43	43	43
	Maximum Insertion Loss (dB)	V_C=-10V	0.2	0.5	0.5	0.7	0.8	1.0	1.5
	Maximum SWR		1.5	1.5	1.5	1.5	1.7	1.7	2.0
33634A	Minimum Isolation (dB)[1]	I_C=200mA	40	40	60	80	80	80	80
	Maximum Insertion Loss (dB)	V_C=-10V	0.3	0.5	0.8	0.8	1.0	1.2	2.0
	Maximum SWR		1.5	1.5	1.6	1.7	1.7	1.7	2.0

Note 1. 3-6dB improvement in isolation in the frequency range 0.1-12 GHz can be realized by increasing bias current to 100mA.

Typical Characteristics

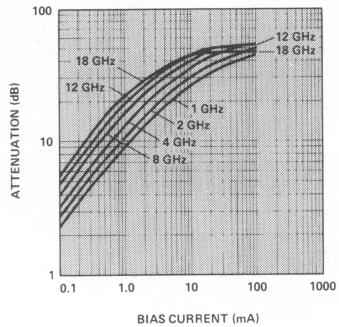


Figure 4. Attenuation of the 33632A as a Function of Bias Current with Frequency as a Parameter.

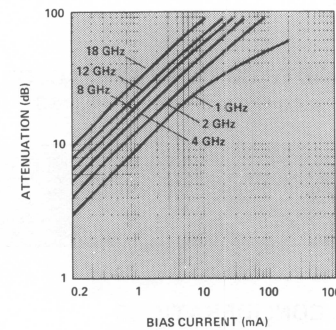


Figure 5. Attenuation of the 33634A as a Function of Bias Current with Frequency as a Parameter.

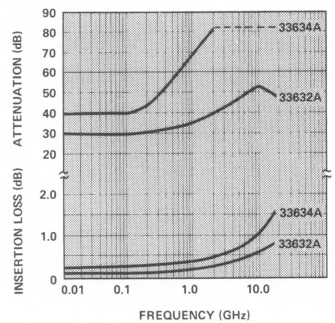


Figure 6. Typical Attenuation and Insertion Loss vs. Frequency.

Ordering Information

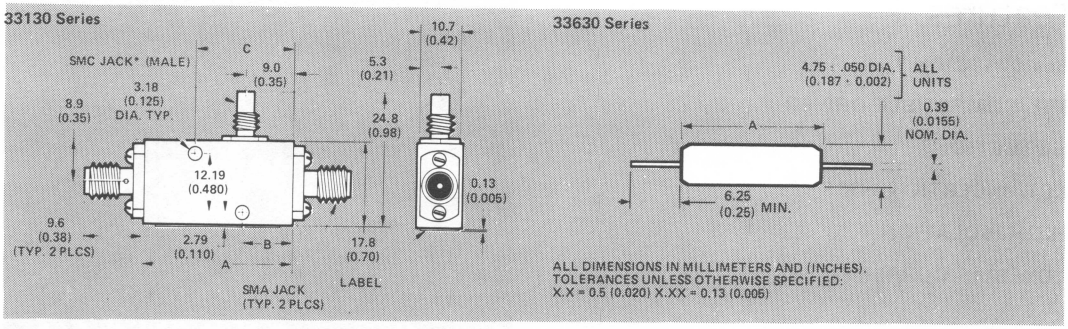
33130 Series General Purpose Switches

The 33130 series switch is a broadband general purpose switch. The standard unit is supplied with SMA jack (female) RF connectors and SMC jack bias connector. An SMA jack bias connector is available as Option 001.

33630 Series Coaxial Modules

The 33630 coaxial switch module is the basic building block for all other switch models. It is ordered by model number without option numbers.

Outline Drawings



Model	A	B	C
33132A	31.8 (1.25)	9.7 ± 0.25 (0.383 ± 0.010)	21.9 ± 0.25 (0.863 ± 0.010)
33134A	37.3 (1.47)	12.5 ± 0.25 (0.493 ± 0.010)	24.7 ± 0.25 (0.973 ± 0.010)

*SMA Jack available as Option 001.

Models	A
33632A	10.92 ± 0.20 (0.430 ± 0.008)
33634A	16.51 ± 0.20 (0.650 ± 0.008)

Mechanical Specifications

Size: See Outline Drawings.

Finish: 33130 Series – Body: painted.

33630 Series – Gold plated (50μ inches minimum).

	33130 Series		33630 Series
Maximum Weight	33132A	33134A	All
Ounces	0.8	1.0	0.07
Grams	23	29	2

Environmental Capabilities

33130 Series:

Non-Operating Temperature Cycling: MIL-STD-883. Method 1010. Test Condition B (-55° C to +125° C).

Operating Temperature: MIL-E-5400 Table I, Class 2 (-55° C to +95° C continuous).

Shock: MIL-STD-883. Method 2002. Test Condition B.

Moisture Resistance: MIL-STD-883. Method 1004.

Salt Atmosphere: (corrosion) MIL-STD-883. Method 1009. Test Condition A.

33630 Series:

Non-Operating Temperature: -65° C to +150° C.

Operating Temperature: -65° C to +150° C.

Temperature Cycling: MIL-STD-750. Method 1051. Test Condition B.

Thermal Shock: MIL-STD-750. Method 1056. Test Condition A.

Humidity: MIL-STD-750. Method 1021, omit initial conditioning.

Shock: MIL-STD-750. Method 2016, 5 blows each X_1, Y_1, Y_2, Z orientations, 0.5 msec pulse, 1500 G min., non-operating.

Vibration: MIL-STD-750. Method 2056.

Constant Acceleration: MIL-STD-750. Method 2006, 2000G.

HEWLETT PACKARD

FAST MICROWAVE SPST SWITCHES DC-18GHz

33142A
33144A
33642A
33644A

Features

5ns SWITCHING

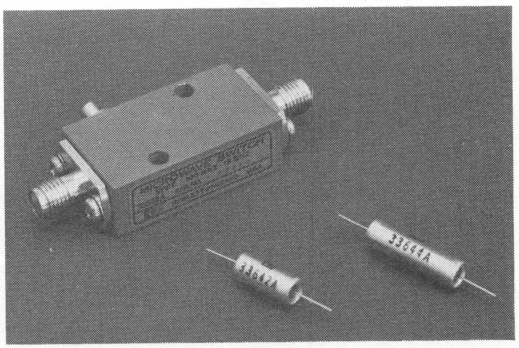
TTL COMPATIBLE DRIVER

HERMETIC

LOW INSERTION LOSS

HIGH ISOLATION

LOW BIAS CURRENT



Description

The HP 33140 Series switches utilize HP's fastest PIN diodes in shunt across a 50Ω transmission line. The PIN diode presents a very high impedance with reverse bias. With the diode in shunt, the switch is "on" with reverse bias (well matched and passing all the incident RF power). Approximately 10mA of DC current per diode reduces this impedance to much less than 50Ω. Thus the switch is "off" when the diode is forward biased (high mismatch reflecting most of the power back to the source). The PIN diode allows a smooth and repeatable variation of attenuation with change in bias level.

The basis of the HP SPST switch product line is a hermetic coaxial module. The 33640 series module is optimized for fast switching, low insertion loss and high isolation. The modules are available with either two or four diodes. Units using three diodes are available on special order.

The HP 33140 series are complete switches, with RF connectors, bias circuit, and built-in DC return. The HP 33190B TTL compatible driver is recommended for use with this switch series.

For further technicai details, see HP Application Notes 922, "Applications of PIN Diodes" and 932, "Selection and Use of Microwave Diode Switches and Limiters".

Switch Schematics

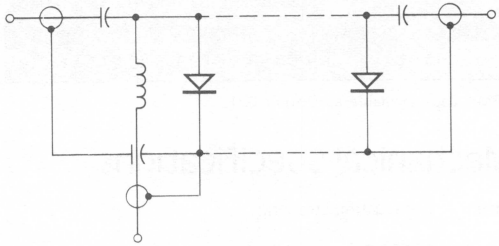


Figure 1. Switch Assembly Schematic. 33140 Series

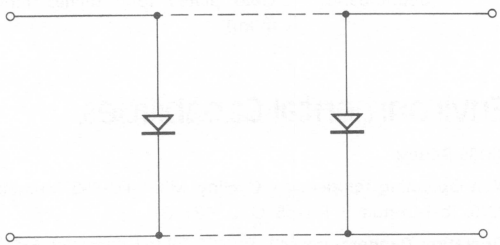


Figure 2. Module Schematic. 33640 Series

Model	Diode Polarity	Number of Diodes
33142A, 33642A	As Shown	2
33144A, 33644A	As Shown	4

Maximum Ratings

Parameter	33142A	33144A	33642A	33644A
Operating Temperature	-55°C to +95°C		-65°C to +150°C	
Storage Temperature	-55°C to +125°C		-65°C to +150°C	
CW RF Power at T_C = 25°C	2W (Derate linearly to .85 at 95°C)		2W (Derate linearly to zero at 150°C)	
Pulse RF Power at T_C = 25°C (1 μs, 0.001 duty cycle)	16W (Derate linearly to 7W at 95°C)		16W (Derate linearly to zero at 150°C)	
Control Current	+200 mA	+400 mA	+200 mA	+400 mA
Control Voltage	-60V to +1V		-60V to +1V	

Electrical Specifications

RF POWER HANDLING

The breakdown voltage of the diode, the maximum diode power dissipation, the bias state and the frequency of the RF signal all determine the maximum RF power a switch can handle.

PULSE WIDTH CORRECTION FACTOR

Apply to Incident Power Ratings of Figure 3.

Pulse Width	Correction Factor
0.5 μs	1.5
2.0 μs	0.7

DRIVING CONSIDERATIONS:

The recommended driver for the HP 33142A/33144A switch is the HP 33190B Add-on Switch Driver. The 33190B requires +5 volts and -12 volts bias power supplies and has TTL compatible input. The 33190B output port connects directly to the SMC control port of the 33142A/33144A switch.

Due to the broad RF bandwidth of the 33142A and 33144A, Video switching spikes from the switch driver will appear at the RF input and output connectors. Depending on the application, video filtering or attenuators may be required to minimize Video feed through and/or ringing on RF pulses due to multiple reflections of video spikes down the RF lines.

NOISE FIGURE

Equal to attenuation.

DISTORTION

Internally generated harmonics are 20dB below the fundamental from 1 to 4 GHz at either full isolation or insertion loss for input power levels up to ½ watt. Above 4 GHz harmonics are down 40dB.

RF TO DC ISOLATION

Isolation of the RF from the control circuit is typically 30dB.

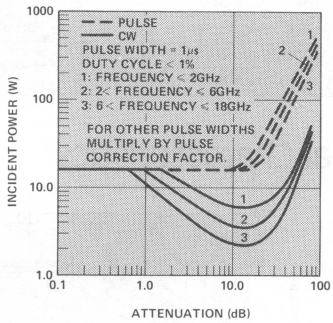
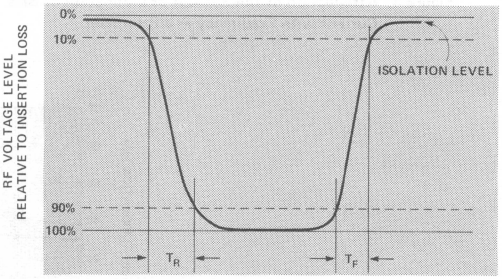


Figure 3. Incident Pulse and CW Power Ratings vs. Attenuation. See Table for Pulse Correction Factor (T_C = 25°C)

SWITCHING SPEED AT 25° C:

T_R (10% - 90% RF Voltage) = 5 ns Max.
T_F (90% - 10% RF Voltage) = 7 ns Max.



Test Condition at 10GHz:
33142 I_C (Off) = 20mA, V_C (On) = -10V
33144A I_C (Off) = 40mA, V_C (On) = -10V

Electrical Specifications at $T_{CASE}=25°C$

33140 SERIES SWITCHES

Model	Parameter	Conditions	Frequency Range (GHz)					
			.1-1.0	1.0-2.0	2.0-4.0	4.0-8.0	8.0-12.0	12.0-18.0
33142A	Minimum Isolation (dB)	I_C=20 mA	25	30	40	45	45	45
	Maximum Insertion Loss (dB)	V_C=-10V	1.0	1.0	1.0	1.5	1.5	2.5
	Maximum SWR		1.7	1.9	1.9	1.9	1.9	2.2
33144A	Minimum Isolation (dB)	I_C=40 mA	35	60	80	80	80	80
	Maximum Insertion Loss (dB)	V_C=-10V	1.0	1.1	1.4	1.7	2.0	3.0
	Maximum SWR		1.7	2.0	2.0	2.0	2.0	2.5

33640 SERIES MODULES

Model	Parameter	Conditions	Frequency Range (GHz)						
			DC-0.1	0.1-1.0	1.0-2.0	2.0-4.0	4.0-8.0	8.0-12.0	12.0-18.0
33642A	Minimum Isolation (dB)	I_C=20 mA	22	25	30	40	45	45	45
	Maximum Insertion Loss (dB)	V_C=-10V	0.5	0.5	0.6	0.8	1.0	1.0	2.0
	Maximum SWR		1.7	1.7	1.9	1.9	1.9	1.9	2.1
33644A	Minimum Isolation (dB)	I_C=40 mA	32	35	60	80	80	80	80
	Maximum Insertion Loss (dB)	V_C=-10V	0.5	0.5	0.8	1.0	1.5	1.5	2.5
	Maximum SWR		1.7	1.7	2.0	2.0	2.0	2.0	2.2

Typical Characteristics

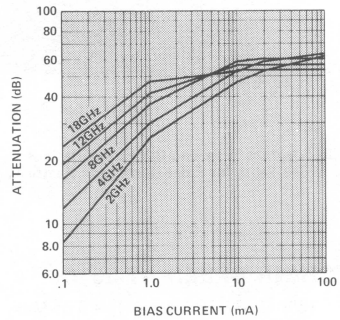


Figure 4. Attenuation of the 33142A as a Function of Bias Current with Frequency as a Parameter.

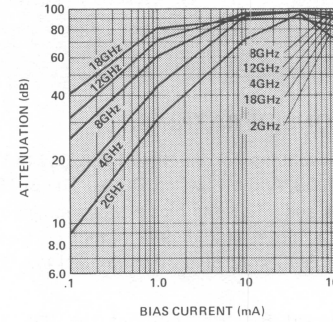


Figure 5. Attenuation of the 33144A as a Function of Bias Current with Frequency as a Parameter.

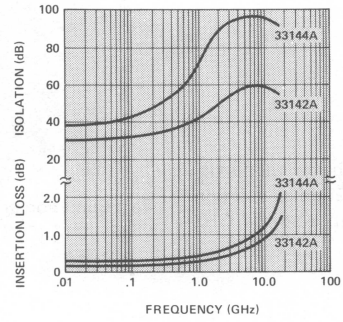


Figure 6. Attenuation and Insertion Loss vs. Frequency.

Ordering Information

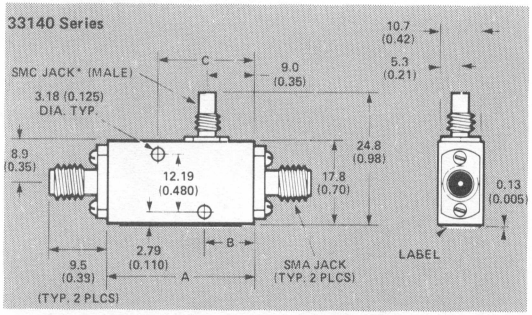
33140 Series Fast Switches

The 33140 series switch is a broadband fast switch. The standard unit is supplied with SMA jack (female) RF connectors and SMC jack bias connector. An SMA jack bias connector is available as Option 001. An add-on driver 33190B is also available.

33640 Series Coaxial Modules

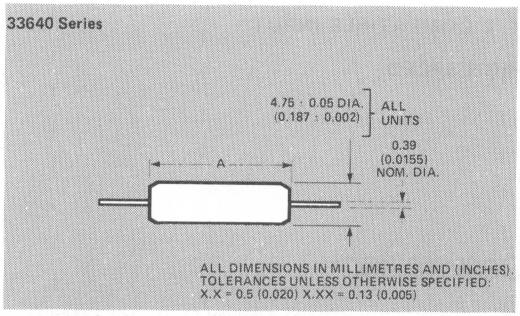
The 33640 hermetic coaxial switch module is the basic building block for all other switch models. It is ordered by model number without option numbers.

Outline Drawings



Model	A	B	C
33142A	31.8 (1.25)	9.7 ± 0.25 (0.383 ± 0.010)	21.9 ± 0.25 (0.863 ± 0.010)
33144A	37.3 (1.47)	12.5 ± 0.25 (0.493 ± 0.010)	24.7 ± 0.25 (0.973 ± 0.010)

*SMA Jack available as Option 001.



Models	A
33642A	10.92 ± 0.20 (0.430 ± 0.008)
33644A	16.51 ± 0.20 (0.650 ± 0.008)

Mechanical Specifications

Size: See Outline Drawings.

Finish: 33140 Series — Body: painted.

33640 Series — Gold plated (50 micro-inches minimum).

Maximum Weight	33140 Series		33640 Series
	33142A	33144A	All
Ounces	0.8	1.0	0.07
Grams	23	29	2

Environmental Capabilities

33140 Series:

Non-Operating Temperature Cycling: MIL-STD-883. Method 1010. Test Condition B (-55° C to +125° C).

Operating Temperature: MIL-E-5400R Table I, Class 2 (-55° C to +95° C continuous).

Shock: MIL-STD-883. Method 2002. Test Condition B.

Moisture Resistance: MIL-STD-883. Method 1004.

Salt Atmosphere: (corrosion) MIL-STD-883. Method 1009. Test Condition A.

33640 Series:

Non-Operating Temperature: -65° C to +150° C.

Operating Temperature: -65° C to +150° C.

Temperature Cycling: MIL-STD-750. Method 1051. Test Condition B.

Thermal Shock: MIL-STD-750. Method 1056. Test Condition A.

Humidity: MIL-STD-750. Method 1021, omit initial conditioning.

Shock: MIL-STD-750. Method 2016, 5 blows each X_1, Y_1, Y_2, Z orientations, 0.5 msec pulse, 1500 G min., non-operating.

Vibration: MIL-STD-750. Method 2056.

Constant Acceleration: MIL-STD-750. Method 2006, 2000G.

HEWLETT PACKARD

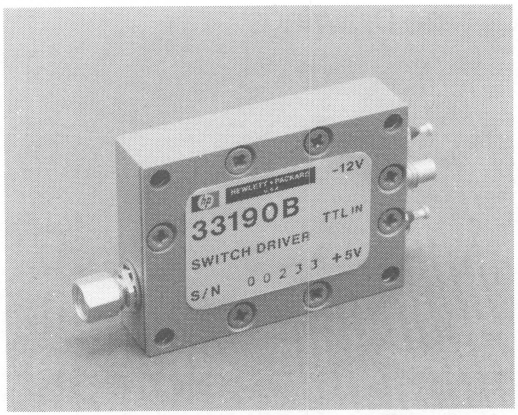
SWITCH DRIVER FOR FAST SPST PIN DIODE SWITCHES

33190B

Features

TTL COMPATIBLE INPUT

HIGH SPEED



Description

The HP 33190B is a driver designed for the HP 33140 Fast SPST switch series. The fully TTL compatible driver simplifies high speed switching by converting the TTL inputs to the required switching bias levels. The HP 33190B requires +5V and -12V bias supplies. Its output connector mates directly with the SMC control port connector on the HP 33140 series switches.

Applications

To achieve nanosecond switching times with diode switches, a specially shaped switching impulse is required to compensate for PIN diode minority carrier lifetime. Since minority carrier lifetime is a diode parameter and varies greatly for different classes of diodes, drivers are designed to optimize switching time for a specific diode/switch. The HP 33190B is designed specifically for the HP 33142A and 33144A model switches, but can be used to improve switching time of any SPST diode switch.

Maximum Ratings

Operating Temperature . . . . . -55°C to 95°C

Storage Temperature . . . . . -55°C to 125°C

Electrical Specifications at T_{CASE} = 25°C

Driver Input Control Levels

Switch Mode(1)	Logic State	Input Voltage	Max. Input Current
Minimum Insertion Loss	0	0-0.8V	4 mA Sink
Isolation	1	2.5V Min.	50μA(2) Source

Bias Supply Voltages:

+5V ± 5%

-12V ± 5%

Note 1. Inverted for 33102A/33104A.

Note 2. Increases for V_{IN} greater than 2.5V. Input impedance approximately 1KΩ for V_{IN} greater than 2.5V.

Bias Supply Currents (Maximum)

HP Switch Type	+5V	-12V
33142A/33144A 33132A/33134A	80 mA	10 mA
33102A/33104A	10 mA	80 mA

Steady State Output Levels

Logic State	Typical Open Circuit Voltage	Minimum Available Output Current
0	-10V	40 mA
1	+3V	40 mA

Switching Considerations

Switch Being Driven	T_R (ns)	T_F (ns)	T_{DR} (ns)	T_{DF} (ns)
33142A 33144A (Max)	5	7	26 (Typ)	30 (Typ)
33102A 33104A (Typ)	100	20	—	—
33132A 33134A (Typ)	150	50	—	—

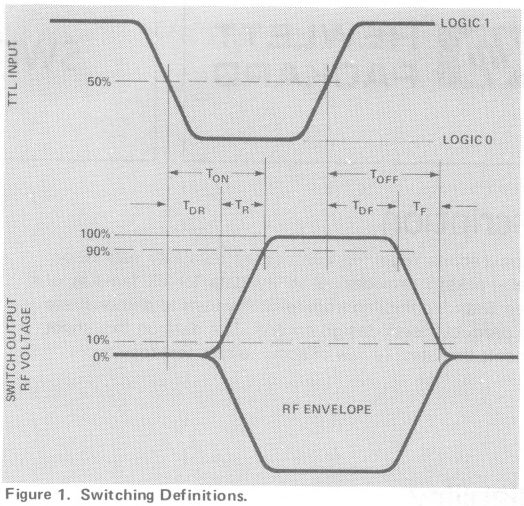


Figure 1. Switching Definitions.

Environmental Capabilities

Non-Operating Temperature Cycling: MIL-STD-883. Method 1010. Test Condition B (-65° C to +125° C).

Operating Temperature: MIL-E-5400 Table I, Class 2 (-65° C to +95° C continuous).

Shock: MIL-STD-883. Method 2002. Test Condition B.

Moisture Resistance: MIL-STD-883. Method 1004.

Salt Atmosphere: (corrosion) MIL-STD-883. Method 1009. Test Condition A.

Definitions (Figure 1)

T_R = 10% to 90% Switch RF voltage.

T_F = 90% to 10% Switch RF voltage.

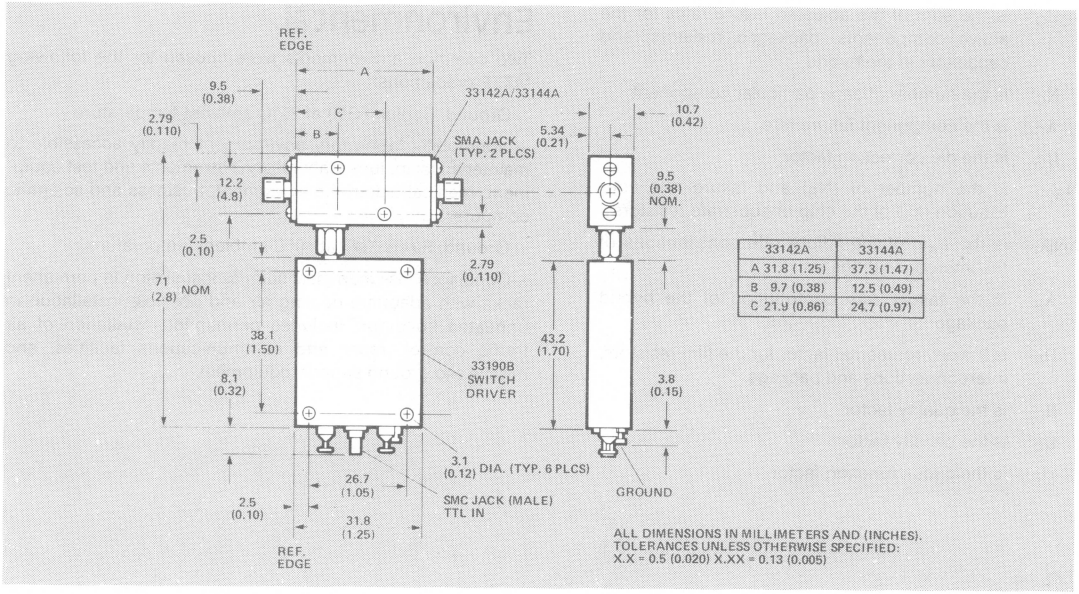
T_{DR} = Time delay from 50% driver input voltage to 10% switch RF output voltage.

T_{DF} = Time delay from 50% driver input voltage to 90% switch RF output voltage.

$T_{ON} = T_{DR} + T_R$

$T_{OFF} = T_{DF} + T_F$

Outline Drawing



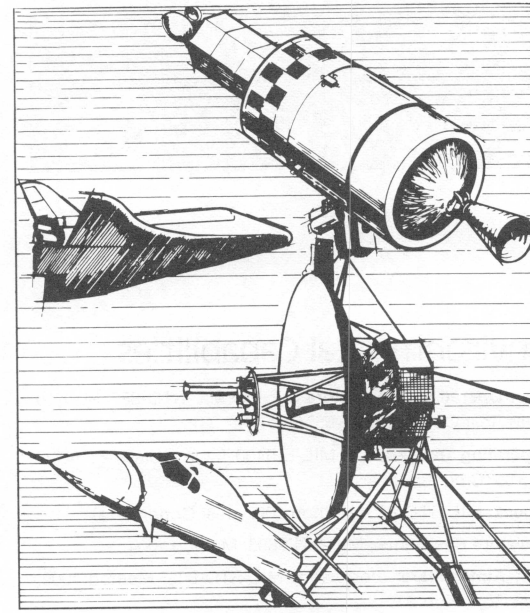
	33142A	33144A
A	31.8 (1.25)	37.3 (1.47)
B	9.7 (0.38)	12.5 (0.49)
C	21.9 (0.86)	24.7 (0.97)

HEWLETT PACKARD

RELIABILITY DATA SWITCHES, SWITCH DRIVERS, MODULATORS

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests to demonstrate that a product meets design criteria. The data on this sheet represents the latest review of accumulated test results.



Reliability

Each design is tested for performance under varying conditions of temperature, humidity, vibration and mechanical shock. Sample production units undergo life testing to demonstrate predicted MTTF for selected product designs.

The following MTTF (Mean Time To Failure) hours have been calculated from the failure rate predictions found in MIL-HDBK-217D, Reliability Prediction of Electronic Equipment. The Hybrid Microcircuit failure rate model was used:

$$\lambda_p = \left\{ \Sigma N_C \lambda_C \Pi_G + [N_R \lambda_R + \Sigma N_I \lambda_I + \lambda_S] \Pi_F \Pi_E \right\} \Pi_Q \Pi_D$$

(failures/10^6 hour)

where:

$MTTF = 1/\lambda_p$

$\Sigma N_C \lambda_C \Pi_G$ is the sum of the adjusted failure rates for the active components, packaged resistors, and capacitors in the hybrid

N_C is the number of each particular component

λ_C is the component failure rate

Π_G is the die correction factor

$N_R \lambda_R$ is the number of (N_R) and failure rate contribution (λ_R) of the chip or substrate resistors

$\Sigma N_I \lambda_I$ is the sum of the failure rate contributions of the interconnections (λ_I)

λ_S is the failure rate contribution of the hybrid package

Π_E is the environmental factor for the film resistors, interconnections and package

Π_Q is the quality factor

Π_D is the density factor

Π_F is the circuit function factor

Environmental

Two common environments were chosen for the following MTTF predictions:

Ground, Benign (GB) at 25°C ambient temperature

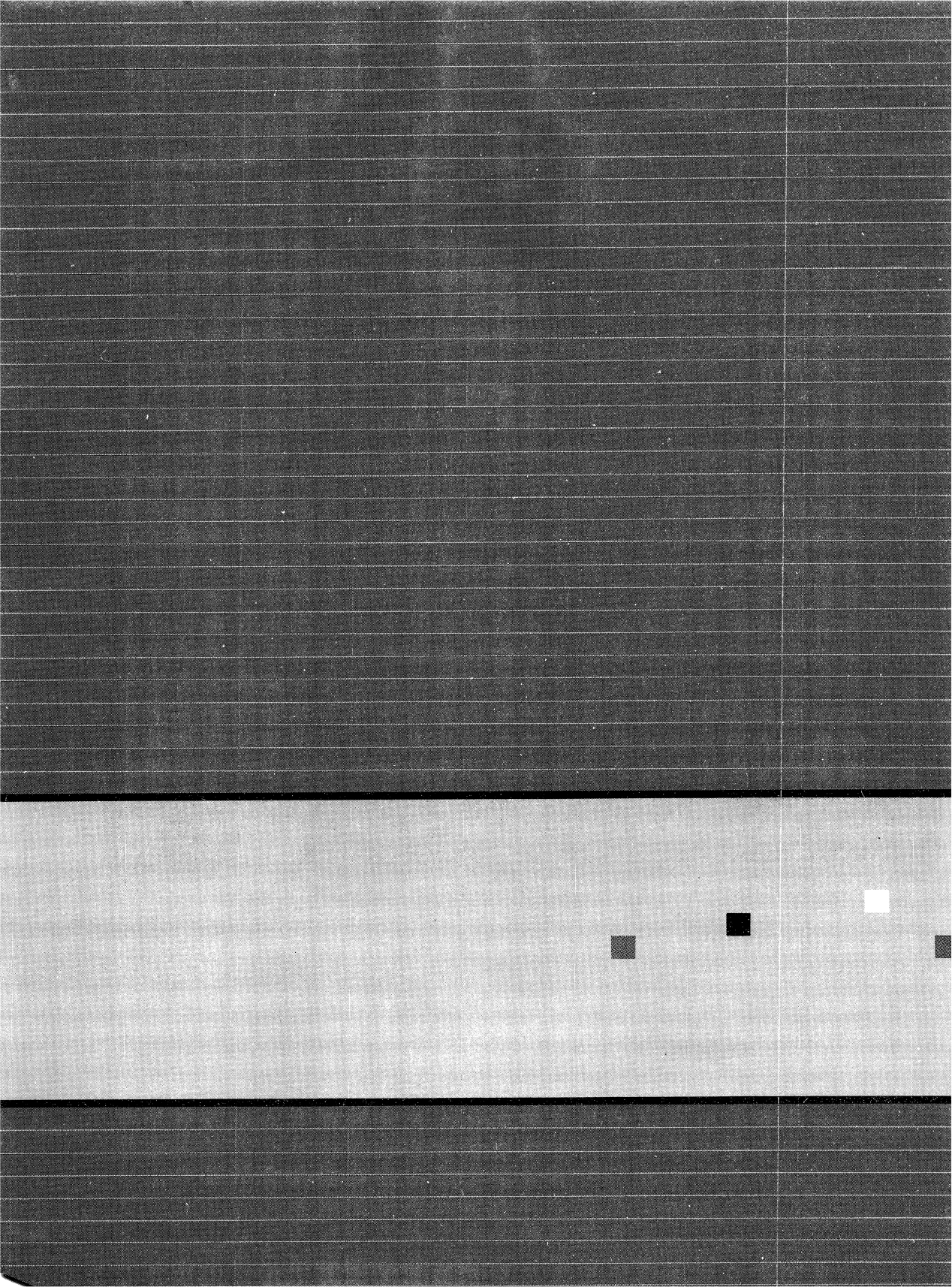
—Nonmobile, laboratory environment readily accessible to maintenance; includes laboratory instruments and test equipment, medical electronic equipment, business and scientific computer complexes.

Ground, Fixed (GF) at 40°C ambient temperature

—Conditions less than ideal such as installation in permanent racks with adequate cooling air and possible installation in unheated buildings; includes permanent installation of air traffic control, radar and communications facilities, and missile silo ground support equipment.

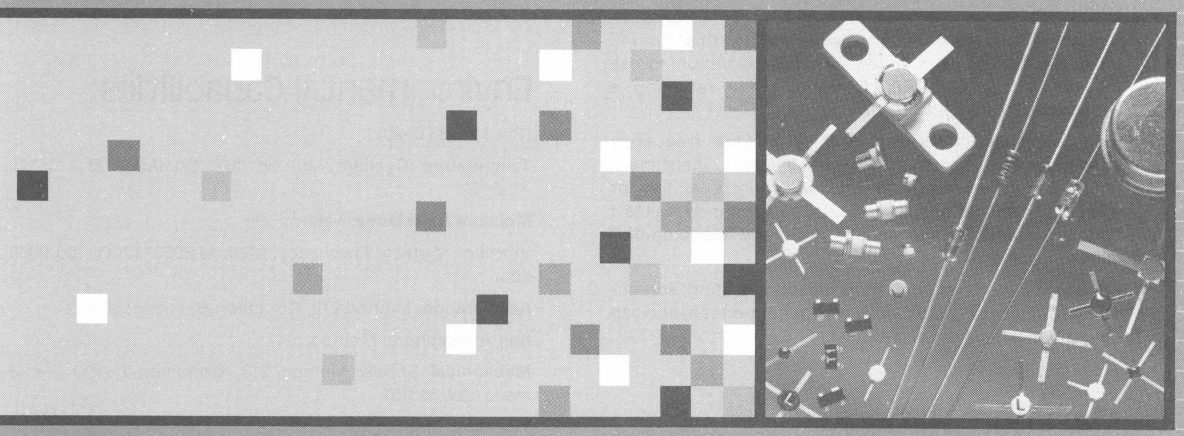
MTTF Summary

Product Family	Part Number	Environment	Ambient Temperature °C	MTTF Hours × 10^6
Absorptive Modulator	33000C	GB	25	30.23
	33000C	GF	40	6.50
	33000D	GB	25	17.98
	33000D	GF	40	3.81
	33001C	GB	25	23.28
	33001C	GF	40	4.77
	33001D	GB	25	14.94
	33001D	GF	40	3.12
	33008C	GB	25	26.84
	33008C	GF	40	5.49
	33008D	GB	25	16.63
	33008D	GF	40	3.40
General Purpose Microwave Switch	33016C	GB	25	15.59
	33016C	GF	40	3.71
	33102A	GB	25	23.29
	33102A	GF	40	6.02
	33104A	GB	25	13.56
	33104A	GF	40	3.23
SPST Low Loss Microwave Switch	33132A	GB	25	23.38
	33132A	GF	40	6.02
	33134A	GB	25	13.56
	33134A	GF	40	3.23
SPST Fast Microwave Switch	33142A	GB	25	23.38
	33142A	GF	40	6.02
	33144A	GB	25	13.56
	33144A	GF	40	3.24
SPST General Purpose Switch Module	33602A	GB	25	40.21
	33602A	GF	40	8.58
	33604A	GB	25	18.69
	33604A	GF	40	4.01
SPST Low Loss Switch Module	33632A	GB	25	40.21
	33632A	GF	40	8.58
	33634A	GB	25	18.70
	33634A	GF	40	4.01
SPST Fast Switch Module	33642A	GB	25	40.21
	33642A	GF	40	8.58
	33644A	GB	25	18.70
	33644A	GF	40	4.01



Mixers and Detectors

- Wideband Double Balanced Mixer
  2-12.4 GHz, Usable to 18 GHz 11-2
- Broadband Double Balanced Mixers
  0.05-500 MHz 11-4
- Reliability Data 11-10



HEWLETT PACKARD

WIDEBAND DOUBLE BALANCED MIXER 2-12.4 GHz

HMXR-5001

Features

WIDEBAND — 2 TO 12.4 GHz
Usable to 18 GHz

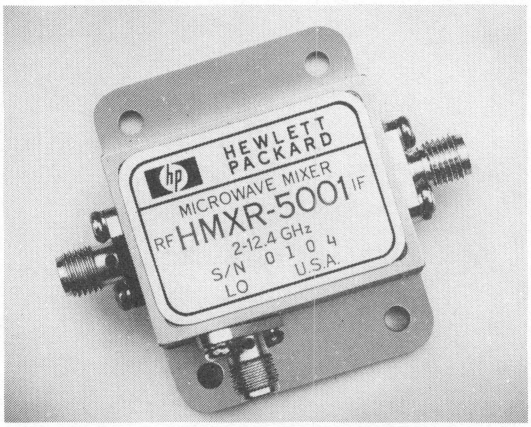
WIDE IF BANDWIDTH
0.01 to 1.0 GHz

GOOD CONVERSION LOSS
7.5 dB Typical to 8 GHz
8.5 dB Typical to 12.4 GHz

EXCELLENT ISOLATION
LO-RF: 30 dB Typical

RUGGED CONSTRUCTION

HERMETICALLY PACKAGED DIODES



Description/Applications

The HMXR-5001 is a double balanced mixer which provides excellent broadband performance and reliability. High performance Schottky beam lead quad technology combined with innovative design and packaging, allows the use of hermetically sealed diodes in a low parasitic configuration.

Designed for use in harsh environments, this rugged mixer has low conversion loss and high isolation across the full 2-12.4 GHz RF/LO band, while retaining a wideband IF of 0.01-1.0 GHz.

Ideal applications for the HMXR-5001 are frequency conversions in electronic warfare systems, instrumentation, and measurement systems. Although specified for wideband applications, its superior performance makes it equally suitable for narrowband radar and telecommunication.

For applications requiring high reliability testing, screened Schottky beam lead diodes are recommended, and can be used in the mixer on request.

Maximum Ratings

Total Input Power at 25°C at 100mW
(Derate linearly to zero at 125°C)
Operating Temperature Range ..... -65°C to 125°C
Non-Operating Temperature Range ... -65°C to 125°C

Frequency Ranges

RF Port: 2 to 12.4 GHz
LO Port: 2 to 12.4 GHz
IF Port: 0.01 to 1.0 GHz

Environmental Capabilities

(Per MIL-STD-202)

Temperature Cycling: Method 107, Condition B (-65°C, +125°C).

Moisture Resistance: Method 106.

Vibration Variable Frequency: Method 2056* (20G, 100-2000 cps)

Acceleration: Method 212, Condition B (except 5000G).

Salt Atmosphere: Method 1041.

Mechanical Shock: Method 213, Condition I (100 G's, 6 msec, saw tooth).

Vibration: Method 201.

Barometric Pressure: Method 105, Condition D (100,000 ft.)

*MIL-STD-750

Electrical Specifications at 25°C

Parameter		2-8 GHz			8-12.4 GHz			Units	Conditions
		Min.	Typ.	Max.	Min.	Typ.	Max.		
Conversion Loss		—	7.5	8.5	—	8.5	9.5	dB	IF = 500MHz P_{LO} = +7 to +13dBm
Isolation	LO-RF	30	35	—	23	30	—	dB	P_{LO} = +7 to +13dBm
	LO-IF	20	25	—	16	23	—	dB	

Conversion Loss vs. LO Drive Level

The HMXR-5001 is specified for drive levels from +7 to +13 dBm. Operation with +3 dBm LO drive will typically result in less than 0.5 dB degradation of conversion loss.

Conversion Loss vs. Temperature

At -55°C the conversion loss is typically unchanged from that at 25°C. At 85°C the conversion loss is typically 0.5 dB more than that at 25°C.

Typical Parameters at 25°C

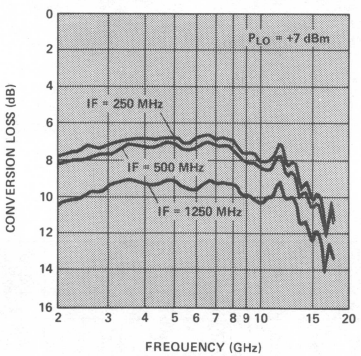


Figure 1. Conversion Loss vs. Frequency.

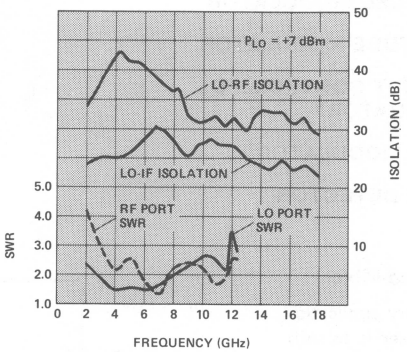


Figure 2. SWR and Isolation vs. Frequency.

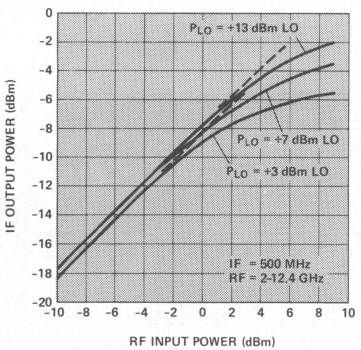
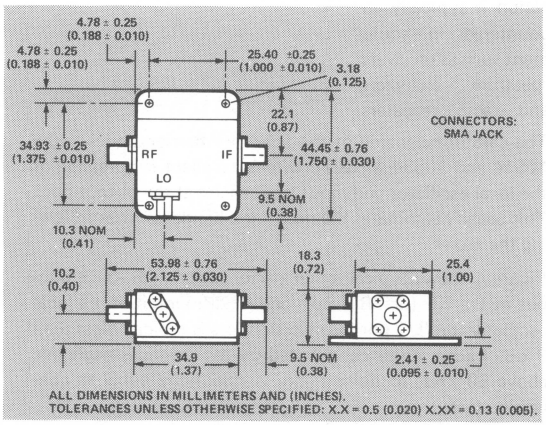


Figure 3. Conversion Compression.



Outline Drawing

HEWLETT PACKARD

DOUBLE BALANCED MIXERS (0.05-500 MHz)

MODELS
10514A/B/C
10534A/B/C

Features

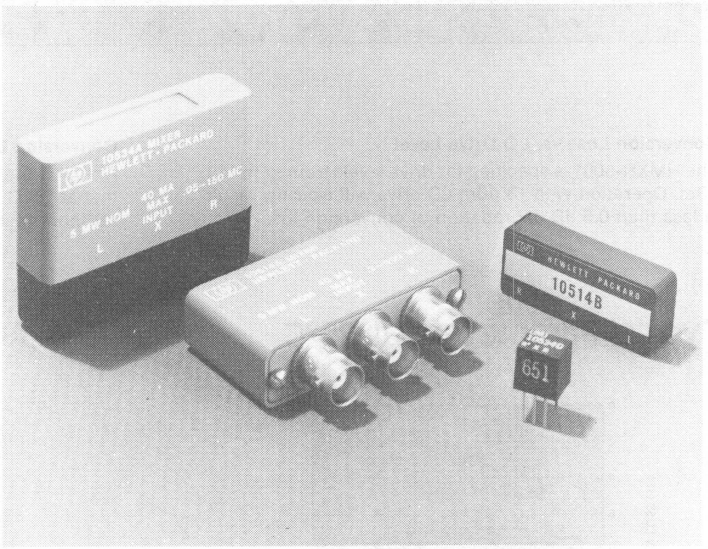
BROADBAND

LOW CONVERSION LOSS

LOW 1/F NOISE

HIGH ISOLATION BETWEEN PORTS

WIDE RANGE OF PACKAGE STYLES AND CONNECTOR OPTIONS



Applications

BALANCED MIXER

BALANCED MODULATOR

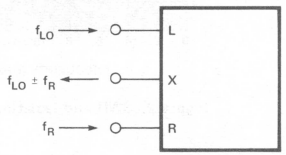
AMPLITUDE MODULATOR

CURRENT CONTROLLED ATTENUATOR

PULSE MODULATOR

PHASE DETECTOR

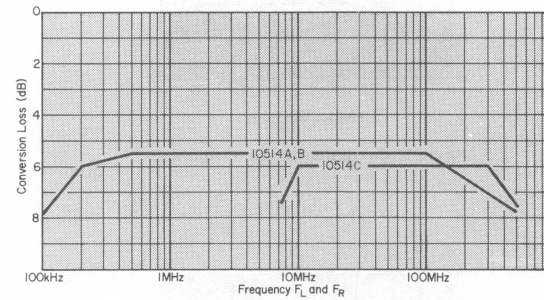
Balanced Mixer



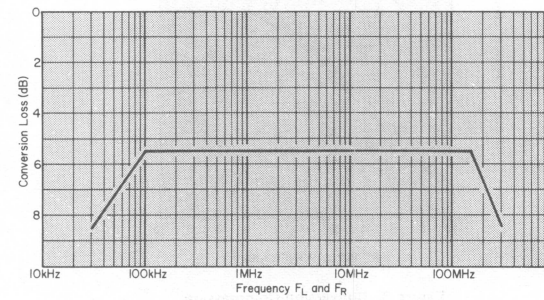
A primary application of a mixer is to shift the spectrum of a signal, usually down in frequency. This application is typically encountered in equipment such as receivers, spectrum analyzers, and radio repeaters.

The careful balancing of the Schottky barrier diodes in the 10514 and 10534 Mixers provides excellent suppression of the local oscillator and input frequencies at the output port. This usually eliminates the need for a bandpass filter following the mixer.

Figure 1 shows typical mixer performance with -3 dBm input at the RF (or "R") port and +7 dBm input at the local oscillator (or "L") port. Conversion loss is typically less than 6 dB. Excess noise contributed by the diodes is negligible above 50 kHz, so noise figure is essentially equal to conversion loss.



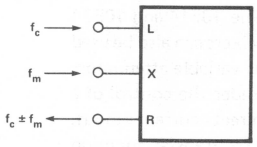
1(a). 10514A/B/C



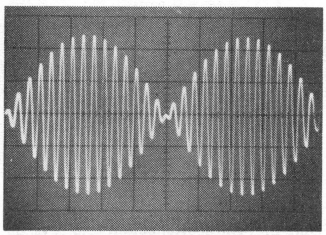
1(b). 10534A/B/C

Figure 1. Typical conversion loss for 10514 and 10534 at 25°C. f_L at +7 dBm, f_R at -3 dBm.

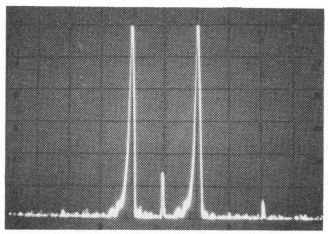
Balanced Modulator



The balanced modulator application is an extension of the frequency conversion mode just described. Here, however, the signal of interest is shifted up from base band and centered on a suppressed carrier, typically at radio frequencies. Both time and frequency domain presentations of the balanced modulator output are shown in Figure 2. Balanced modulator operation is useful, along with the proper filters, for generating the proper frequency components for single sideband, suppressed carrier systems. It is also an inexpensive way to synthesize a two-tone RF signal with stable frequency spacing from an audio and an RF signal source.



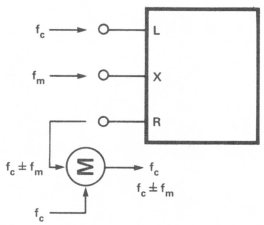
2(a).
Vertical: Uncalibrated
Horizontal: 100 ns/Div.



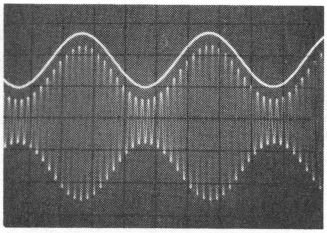
2(b).
Vertical: 10 dB/Div.
Horizontal: 1 MHz/Div.

Figure 2. Frequency and time domain presentations of balanced modulator output of 10514 or 10534. Note suppression of carrier (>40 dB) and absence of higher order sidebands. (Inputs: f_L = 50 MHz at 5 mW, f_X = 1 MHz at 140 mV.)

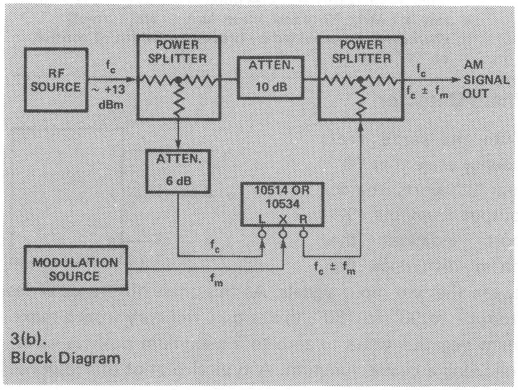
Amplitude Modulator



The balanced modulator output can easily be converted to a conventional amplitude modulated format by reinserting the carrier at the output of the mixer. This is illustrated in Figure 3. Another, although less desirable, way of re-establishing the carrier is to unbalance the unit by applying a direct current bias along with the modulation signal to the "X" port. Generally, however, lower distortion and better control of modulation index result if the carrier is reinserted after the mixer.



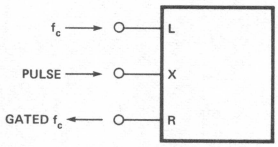
3(a).
Vertical: Uncalibrated
Horizontal: 25 μs/cm



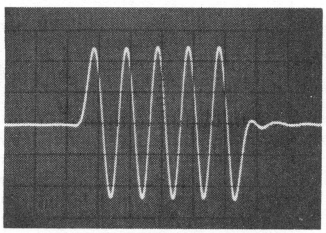
3(b).
Block Diagram

Figure 3. Time domain presentation of amplitude modulated signal constructed by reinserting carrier on balanced modulator output. Time domain display compares modulation signal with resulting envelope of AM signal. Block diagram illustrates method for synthesizing such a signal.

Pulse Modulator



The broad bandwidth of the 10514 and 10534 Mixers allows the current controlled attenuation mode to be extended to pulse modulation. Figure 4 shows both time and frequency domain presentations of a 100 ns wide burst of a 50 MHz carrier. Here power during burst is +4 dBm. Clean bursts with only minimal video feedthrough are provided for RF levels between 0 and +10 dBm by excellent bandwidth and balance. Generally envelope rise time and shape are preserved if frequency spectrum of desired RF output is within bandwidth of "L" and "R" ports (500 MHz for 10514, and 150 MHz for 10534).



4(a).
Vertical: 200 mV/Div.
Horizontal: 20 ns/Div.

4(b).
Vertical: 10 dB/Div.
Horizontal: 7 MHz/Div.

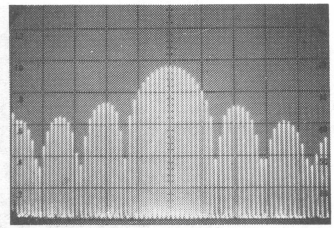
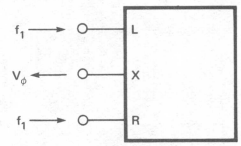


Figure 4. Frequency and time domain presentations of pulse modulated 50 MHz carrier. Pulse burst is 0.1 μs wide; repetition rate is 1 MHz. Note fast, clean turn-on and turn-off characteristics provided by broad bandwidth of control, or "X," port.

Phase Detector



With the same frequency present at "R" and "L" ports, the dc output from the "X" port indicates the phase difference between the two input signals. As this phase difference varies from 0° to 90° to 180°, the output will vary from a maximum negative value to zero to a maximum positive value, following a cosine function. A typical plot of this response is shown in Figure 5.

The specified low frequency (1/f) noise, not usually given for mixers, makes the 10514 and 10534 particularly useful as phase detectors in phase lock loops. They are also valuable in determining the short term, relative stability of high quality signal sources.

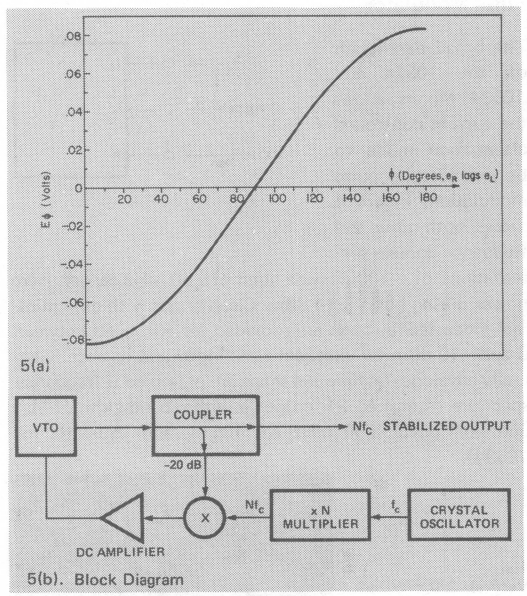
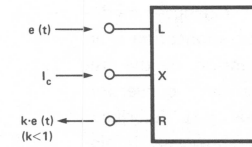


Figure 5. Plot shows typical dc output from "X" port when 10514 or 10534 is used as a phase detector. Guaranteed low 1/f noise qualifies these mixers for use in phase locked sources requiring low fm or phase noise. The accompanying block diagram represents such a stabilized source.

Current Controlled Attenuator



The 10514 and 10534 Mixers can also be used as variable attenuators under the control of a direct current input. The transfer function between "L" and "R" ports depends on the current entering or leaving the normal difference frequency (or "x") port. As shown in Figure 6, a control current of 10 mA will give minimum attenuation, while greater than 40 dB isolation occurs at zero current. Note the wide range of linear attenuation and the low minimum loss.

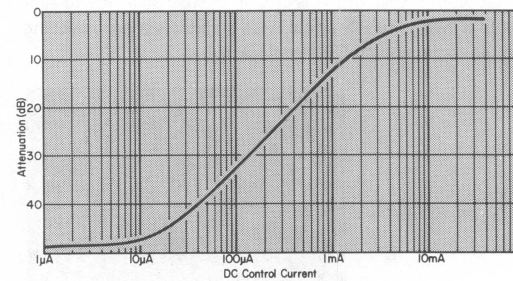
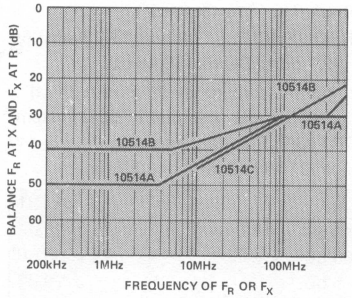


Figure 6. Typical attenuation L to R vs. dc "X" control current; f_L = 30 MHz at 0 dBm.

Typical Isolation

BETWEEN X AND R PORTS

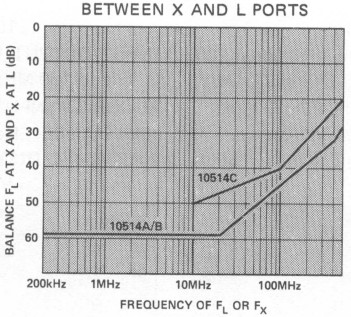


f_R at X with f_R reference. f_L = 40 MHz at +7 dBm. f_R level 0 dBm.

Also

f_X at R with f_X reference. f_L = 40 MHz at +7 dBm. f_X level −5 dBm.

BETWEEN X AND L PORTS

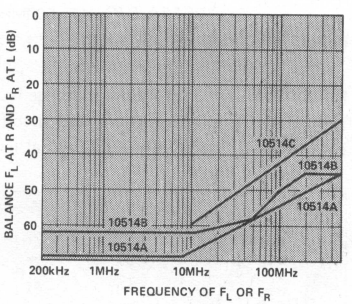


f_L at X with f_L reference. f_R = 40 MHz at 0 dBm. f_L level +7 dBm.

Also

f_X at L with f_X reference. f_L = 40 MHz at +7 dBm. f_X level −5 dBm.

BETWEEN R AND L PORTS



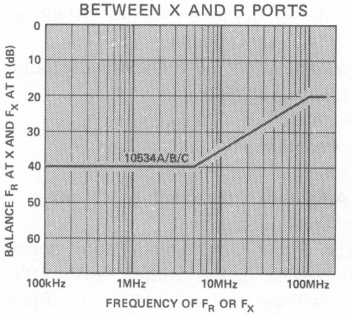
f_R at L with f_R reference. f_L = 40 MHz at +7 dBm. f_R level 0 dBm.

Also

f_L at R with f_L reference. f_R = 40 MHz at 0 dBm. f_L level +7 dBm.

10514A/B/C

BETWEEN X AND R PORTS

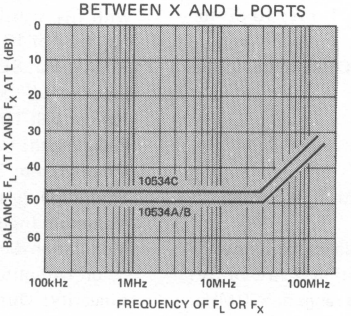


f_R at X with f_R reference. f_L = 40 MHz at +7 dBm. f_R level 0 dBm.

Also

f_X at R with f_X reference. f_L = 40 MHz at +7 dBm. f_X level −5 dBm.

BETWEEN X AND L PORTS

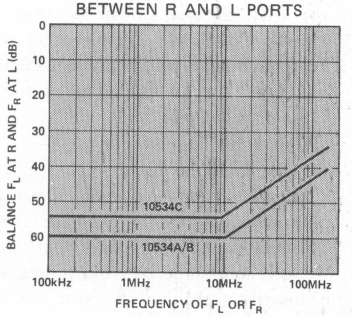


f_L at X with f_L reference. f_R = 40 MHz at 0 dBm. f_L level +7 dBm.

Also

f_X at L with f_X reference. f_L = 40 MHz at +7 dBm. f_X level −5 dBm.

BETWEEN R AND L PORTS



f_L at R with f_L reference. f_R = 40 MHz at 0 dBm. f_L level +7 dBm.

Also

f_R at L with f_R reference. f_L = 40 MHz at +7 dBm. f_R level 0 dBm.

10534A/B/C

Notes/Terminology:

Impedance: The performance of the 10514 and 10534 is specified for 50Ω source and load impedances. The mixers also work well at other impedance levels, including both 75Ω and 93Ω.

Conversion Loss: Conversion loss is the power ratio between the available input power at the "R" port and the power delivered in one of the output sidebands ("L" input = +7 dBm). Conversion loss is not strongly dependent on the available power at the "L" port when this is above 0 dBm.

Noise Performance: For difference frequencies above 50 kHz, noise performance is specified in terms of the relative signal-to-noise ratios at the "R" and "X" ports (i.e., noise figure). The low frequency (1/f) noise contributed by the mixer is specified by the rms noise voltage at the "X" port in a 1 Hz bandwidth centered at 10 Hz.

Conversion Compression: Conversion compression describes the increase in conversion loss that occurs as the input to the "R" port is increased in level. "Compression by f_R alone" implies that f_R is a single frequency input. "Compression by f_{R2} interfering with f_{R1}" describes the decrease in $f_L \pm f_{R1}$ as f_{R2} is increased in level.

Harmonic Distortion: Ideally a mixer produces only sum and difference frequencies of the local oscillator and receive frequencies. Harmonic distortion refers to the higher order mixing products generated when single frequency inputs are impressed on "R" and "L" ports.

Isolation: A double balanced mixer suppresses the "R" port signal appearing at both "L" and "X" ports. Similarly the "L" port signal is suppressed at both "R" and "X" ports. In addition, when used as a modulator, the "X" port signal is suppressed at both "L" and "R" ports. The isolation specification describes how effective this suppression actually is.

Electrical Specifications at T_{CASE} = 25°C

50Ω Source & Load Impedance

10514A/B/C (To 500MHz)

INPUT/OUTPUT FREQUENCIES: "L" and "R" ports: 200 kHz (C: 10 MHz) to 500 MHz: "X" port: DC to 500 MHz.

MAXIMUM INPUT: 40mA (damage level). 80mW (50Ω)

IMPEDANCE: Designed for and specified in 50Ω system.

HARMONIC DISTORTION: Typical levels with f_L = 5mW and f_R = 70mV.

Product	Level†	Product	Level†
$2f_L - f_R$	30 dB	$2f_R - f_L$	65 dB
$3f_L - 2f_R$	70 dB	$3f_R - 2f_L$	65 dB
$4f_L - 3f_R$	70 dB	$4f_R - 3f_L$	85 dB
$5f_L - 4f_R$	90 dB	$5f_R - 4f_L$	90 dB
$6f_L - 5f_R$	95 dB	$6f_R - 5f_L$	100 dB
$7f_L - 6f_R$	100 dB	$7f_R - 6f_L$	100 dB

†Referred to f_X level.

TYPICAL CONVERSION COMPRESSION: By f_R alone: 0.3 dB for 1 mW level. By f_{R2} signal presence interfering with f_{R1} signal: 1 dB for f_{R2} level of 1 mW; 10 dB for f_{R2} level of 10 mW (f_L level at 5 mW).

TYPICAL PULSE MODULATOR PERFORMANCE (pulse input at "X" port, output at "R"):

Rise or Fall Times: 1 ns.

Pulse Width: No restriction.

On-off Ratio: 35 dB.

Saturation Pulse Amplitude: 10mA with f_L = 5 mW.

Maximum Input: 40mA damage level.

Modulation Source: Either + or - polarity turns switch on. Amplitude between pulses, within 2 mV of 0V.

Linearity: Output is linear over a 30 dB range at 500 MHz; better at lower frequencies.

MAXIMUM CONVERSION LOSS

Model	Frequency Range (MHz)		Conversion Loss (dB)
	f_L and f_R	f_X	
A and B	.5 - 50	DC - 50	7.0
	.2 - 500	DC - 500	9.0
C	15 - 250	DC - 250	7.2
	10 - 500	DC - 500	9.0

NOISE PERFORMANCE: 1/F noise typically less than 100 nV per root Hertz at output for f_X at 10 Hz.

MIXER ISOLATION

Model	Freq. Range (MHz)		Isolation (dB)		
	f_L and f_R	f_X	f_L at R	f_L at X	f_R at X
A	.50 - 50	DC - 50	40	40	25
	.2 - 500	DC - 500	30	20	15
B	.5 - 50	DC - 50	40	40	25
	.2 - 500	DC - 500	25	15	15
C	10 - 50	DC - 50	35	35	25
	10 - 150	DC - 150	25	25	20
	10 - 500	DC - 500	20	20	12

10534A/B/C (To 150MHz)

INPUT/OUTPUT FREQUENCIES: "L" and "R" ports: 50 kHz to 150 MHz: "X" port: DC to 150 MHz.

MAXIMUM INPUT: 40mA (damage level). 80mA (50Ω)

IMPEDANCE: Designed for and specified in 50Ω system.

HARMONIC DISTORTION: Typical levels with f_L = 5 mW and f_R = 70mV. f_L = 21 MHz and f_R = 20 MHz.

Product	Level†	Product	Level†
$2f_L - f_R$	40 dB	$2f_R - f_L$	65 dB
$3f_L - 2f_R$	65 dB	$3f_R - 2f_L$	65 dB
$4f_L - 3f_R$	65 dB	$4f_R - 3f_L$	90 dB
$5f_L - 4f_R$	85 dB	$5f_R - 4f_L$	90 dB
$6f_L - 5f_R$	90 dB	$6f_R - 5f_L$	95 dB
$7f_L - 6f_R$	95 dB	$7f_R - 6f_L$	95 dB

†Referred to f_X level.

TYPICAL CONVERSION COMPRESSION: By f_R alone: 0.3 dB for 1 mW level. By f_{R2} signal presence interfering with f_{R1} signal: 1 dB for f_{R2} level of 1 mW; 10 dB for f_{R2} level of 10 mW (f_L level at 5 mW).

TYPICAL PULSE MODULATOR PERFORMANCE (pulse input at "X" port, output at "R"):

Rise or Fall Times: A/B: 1 ns. C: 2 ns.

Pulse Width: No restriction.

On-off Ratio: 35dB.

Saturation Pulse Amplitude: 10mA with f_L = 5 mW.

Maximum Input: 40mA damage level.

Modulation Source: Either + or - polarity turns switch on. Amplitude between pulses, within 2 mV of 0V.

Linearity: Output is linear over a 30 dB input current range at 150 MHz; better at lower frequencies.

MAXIMUM CONVERSION LOSS

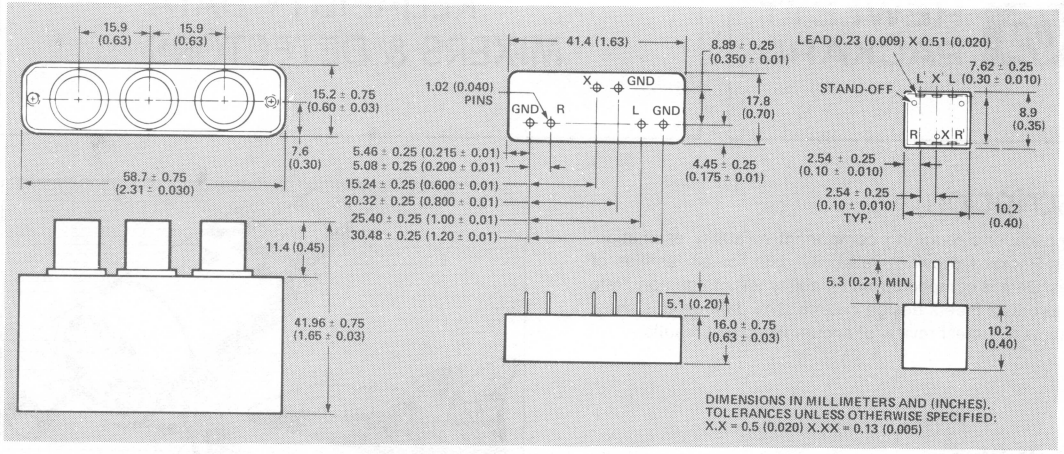
Model	Frequency Range (MHz)		Conversion Loss (dB)
	f_L and f_R	f_X	
A, B & C	.2 - 35	DC - 35	6.5
	.05 - 150	DC - 150	8.0

NOISE PERFORMANCE: 1/F noise typically less than 100 nV per root Hertz at output for f_X at 10 Hz.

MIXER ISOLATION

Model	Freq. Range (MHz)		Isolation (dB)		
	f_L and f_R	f_X	f_L at R	f_L at X	f_R at X
A & B	.05 - 35	DC - 35	40	35	20
	.035-150	DC - 150	30	20	15
C	.05 - 35	DC - 35	35	35	20
	.035-150	DC - 150	25	25	15

Mechanical Specifications



10514A, 10534A **10514B, 10534B** **10514C, 10534C**

Weight:	59g (2.1 oz.)	14g (0.5 oz.)	1.5g (0.053 oz.)
Connectors:	BNC Jack	1.02mm (0.040 in.) Gold Plated Pins	0.51 x 0.23 mm (0.009 x 0.020 in.) Gold Plated Pins

Connector Options, 10514A and 10534A only:

Option 004

Sealectro Snap-on
[No. 51-043-0000]

Maximum Ratings

Operating Temperature
- 10514A/10534A ..... -55°C to +75°C
- 10514B/10534B,C ..... -55°C to +75°C

Storage Temperature
- 10514A/10534A ..... -55°C to +85°C
- 10514B/10534B,C ..... -55°C to +85°C

Input Current (any port, RMS or peak pulse)
- 10514A/10534A 40mA
- 10514B/10534B,C 40mA

Soldering Temperature*
- 10514A/10534A ..... Not Applicable
- 10514B/10534B,C ..... 260°C for 10 seconds

*Lead soldering temperature at distances greater than 0.79mm (1/32 inch) from seating surface.

Environmental Characteristics

Temperature Cycling: MIL-STD-883, Method 1010, Test Condition A (-55° C to +85° C).

Moisture Resistance: MIL-STD-883, Method 1004.

Vibration: MIL-STD-202, Method 204, Test Condition C (10-55 Hz, 0.060 in. p-p; 55-2000 Hz, 10G peak acceleration.)

Shock: MIL-STD-202, Method 213, Test Condition F (1500 G, 0.5 ms).

Barometric Pressure (reduced): MIL-STD-202, Method 105, Test Condition B (50,000 feet) operating.

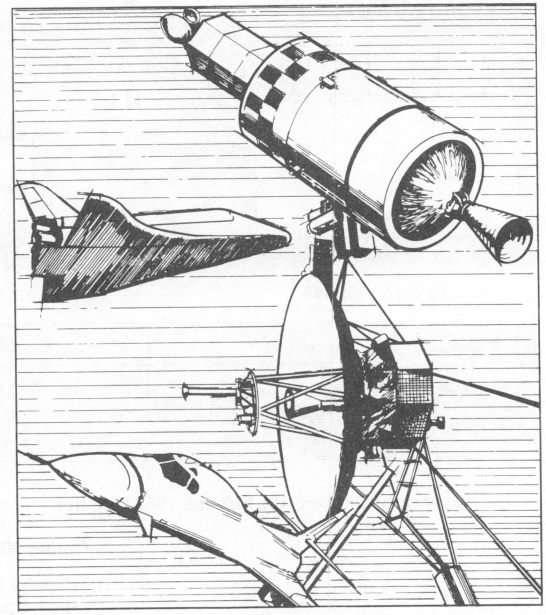
Electromagnetic Interference (10514A, 1053A only): MIL-I-6181.

HEWLETT PACKARD

RELIABILITY DATA
MIXERS & DETECTORS

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests to demonstrate that a product meets design criteria. The data on this sheet represents the latest review of accumulated test results.



Reliability

Each design is tested for performance under varying conditions of temperature, humidity, vibration and mechanical shock. Sample production units undergo life testing to demonstrate predicted MTTF for selected product designs.

The following MTTF (Mean Time To Failure) hours have been calculated from the failure rate predictions found in MIL-HDBK-217D, Reliability Prediction of Electronic Equipment. The Hybrid Microcircuit failure rate model was used:

$$\lambda_p = \left\{ \Sigma N_C \lambda_C \Pi_G + [N_R \lambda_R + \Sigma N_I \lambda_I + \lambda_S] \Pi_F \Pi_E \right\} \Pi_Q \Pi_D$$

(failures/10^6 hour)

where:

$MTTF = 1/\lambda_p$

$\Sigma N_C \lambda_C \Pi_G$ is the sum of the adjusted failure rates for the active components, packaged resistors, and capacitors in the hybrid

N_C is the number of each particular component

λ_C is the component failure rate

Π_G is the die correction factor

$N_R \lambda_R$ is the number of (N_R) and failure rate contribution (λ_R) of the chip or substrate resistors

$\Sigma N_I \lambda_I$ is the sum of the failure rate contributions of the interconnections (λ_I)

λ_S is the failure rate contribution of the hybrid package

Π_E is the environmental factor for the film resistors, interconnections and package

Π_Q is the quality factor

Π_D is the density factor

Π_F is the circuit function factor

Environmental

Two common environments were chosen for the following MTTF predictions:

Ground, Benign (GB) at 25°C ambient temperature

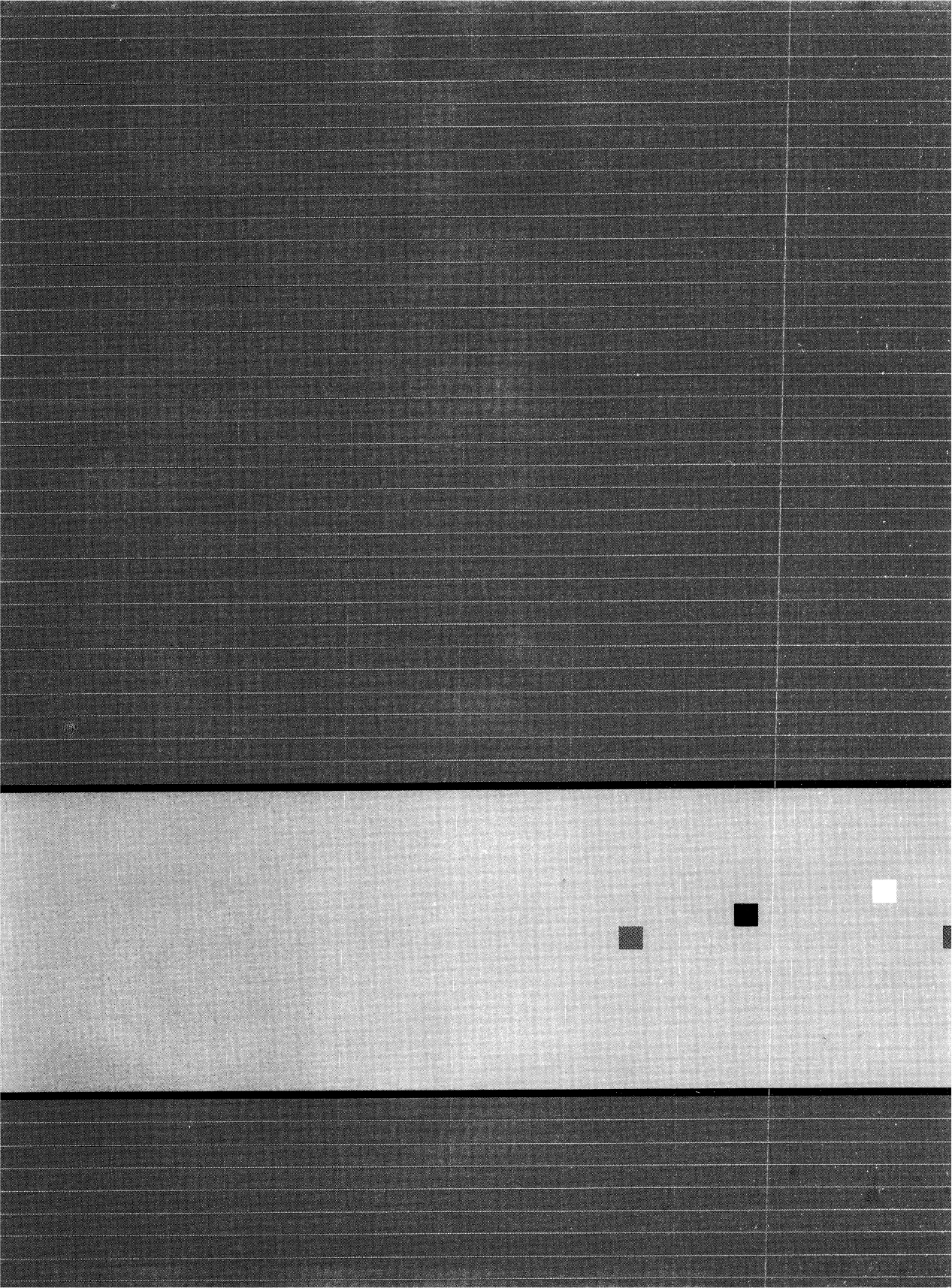
—Nonmobile, laboratory environment readily accessible to maintenance; includes laboratory instruments and test equipment, medical electronic equipment, business and scientific computer complexes.

Ground, Fixed (GF) at 40°C ambient temperature

—Conditions less than ideal such as installation in permanent racks with adequate cooling air and possible installation in unheated buildings; includes permanent installation of air traffic control, radar and communications facilities, and missile silo ground support equipment.

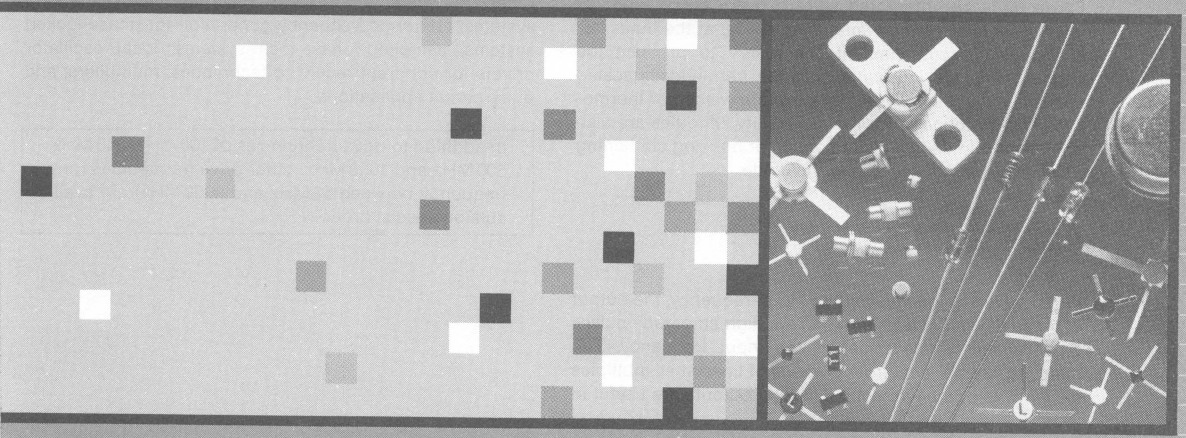
MTTF Summary

Product Family	Part Number	Environment	Ambient Temperature °C	MTTF Hours × 10^6
Double Balanced Mixer	HMXR-5001	GB	25	85.72
	HMXR-5001	GF	40	21.81
	10514A	GB	25	9.33
	10514A	GF	40	1.22
	10514B	GB	25	9.91
	10514B	GF	40	1.19
	10514C	GB	25	9.73
	10514C	GF	40	1.33
	10534A	GB	25	20.31
	10534A	GF	40	2.85
	10534B	GB	25	24.16
	10534B	GF	40	2.91
	10534C	GB	25	12.41
	10534C	GF	40	1.49



Comb Generators

- SRD Comb (Impulse) Generator Modules 100-100 MHz Input Frequency 12-2
- Reliability Data 12-6
- Abstracts of Application Notes 12-7



HEWLETT PACKARD

COAXIAL STEP RECOVERY DIODE MODULES (IMPULSE TRAIN GENERATORS)

33002 A/B
33003 A/B
33004 A/B
33005 C/D

Features

VARIOUS DRIVE FREQUENCIES AVAILABLE
100, 250, 500, 1000 MHz

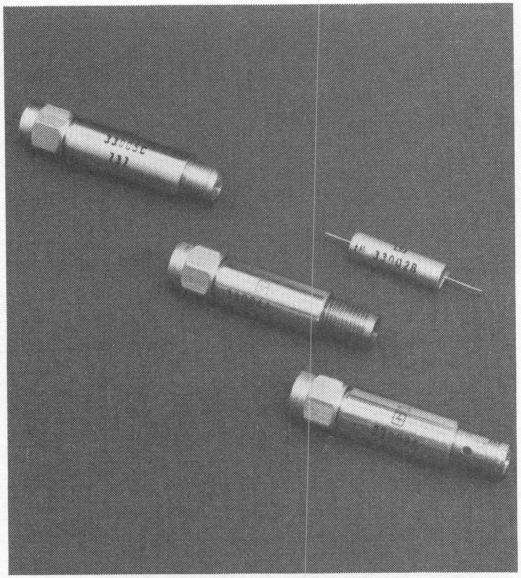
NARROW OUTPUT PULSES
130 Picosecond Pulse Width With
10 Volt Amplitude

BROADBAND OUTPUT COMB
Useful Power at Each Harmonic
through 18 GHz

INPUT MATCHED TO 50Ω

SELF-BIASED
No External Bias Required

RELIABLE
Rugged, Reliable Solid State Hybrid
Integrated Design



Description

These units are integrated step recovery diode "impulse train" generating circuits matched to 50Ω at the input frequency. All circuit elements necessary to produce the impulse train are integrated into the hermetically sealed cylindrical module. All internal joints are welded or thermocompression bonded for high reliability. Modules are also availabe mounted in a 3 mm connector housing containing a DC return which self-biases the diode.

Applications

When driven at the appropriate input frequency, the output of these devices is a train of narrow, high amplitude pulses at a repetition rate equal to the input frequency. The resulting "comb" spectrum consists of lines at all multiples of f_{IN} up to and beyond 18 GHz. The outputs are useful in many applications such as: measurement of the spectral behavior of various linear components (filters and slow wave structures); frequency and amplitude calibration of receivers, systems, and antennas; frequency marking systems; reference frequency generation for phase locked systems; sampling phase-lock systems; local oscillator drivers for coherent receiving techniques; multipliers; and pulse circuit applications.

In addition to drive frequencies of 100 MHz, 250 MHz, 500 MHz and 1000 MHz, other drive frequencies (any frequency between 50 MHz and 3000 MHz) are available on special order.

INPUT SWR

The input SWR is a function of the input power. The devices have all been optimized for minimum SWR at the nominal center frequency with .5 watt drive. Below .5 watts, the SWR begins increasing. The point of minimum SWR may be adjusted if external bias is applied to the diode ("B" and "D" versions only, which have no DC return).

SWR Characteristics

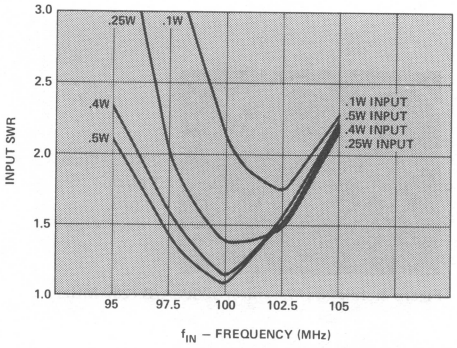


Figure 11. 33002A/B

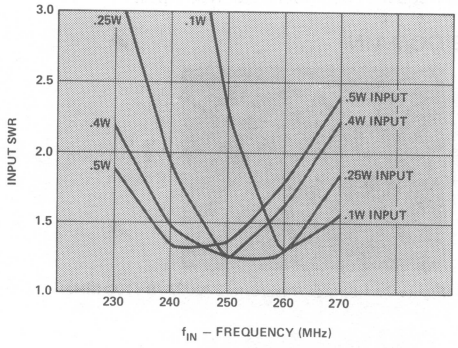


Figure 12. 33003A/B

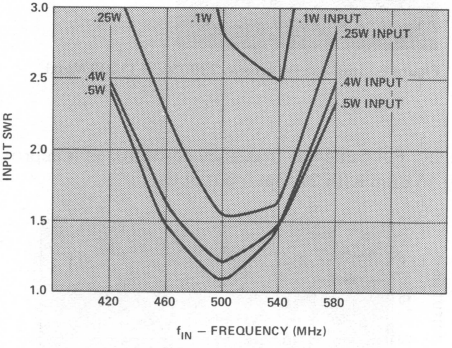


Figure 13. 33004A/B

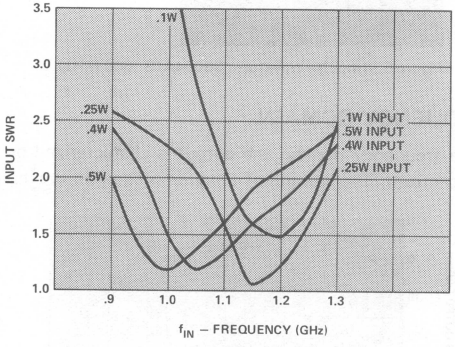


Figure 14. 33005C/D

TEST SET-UPS

Comb generators can be measured in the time domain using a very fast sampling scope, or in the frequency domain using several sweepers (as local oscillators), mixers and an IF amplifier. Measurements made using a spectrum analyzer must be interpreted very carefully because of the large number of spurious responses when driven by the extremely wideband comb generated by these devices. Use of a tracking preselector (HP 8445B) helps eliminate these spurious responses.

The output of these devices consists of a train of very short pulses periodic with the input frequency.

In the time domain, the output is characterized by the pulse height, pulse width and the excess feed-through of the fundamental frequency component to the output.

In the frequency domain the output consists of power at all frequencies which are integral multiples of f_{in} up to and beyond 18 GHz. All specifications are for 0.5 watt drive at 25°C case temperature

TIME DOMAIN

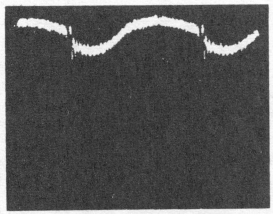


Figure 3. Impulse Waveform 33002A/B (100 MHz)

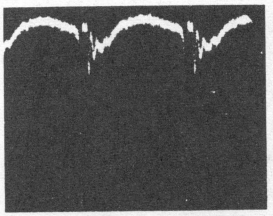


Figure 4. Impulse Waveform 33003A/B (250 MHz)

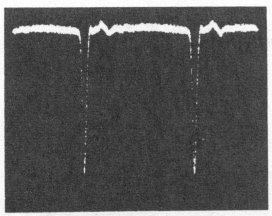


Figure 5. Impulse Waveform 33004A/B (500 MHz)

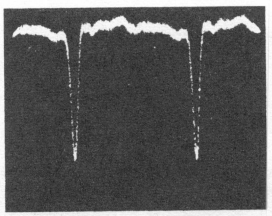


Figure 6. Impulse Waveform 33005C/D (1000 MHz)

FREQUENCY DOMAIN

In the frequency domain the output is characterized by a line spectrum. The spacing of the lines is equal to the input frequency. Fundamental frequency feedthrough is approximately 15 dBm with 27dBm input power.

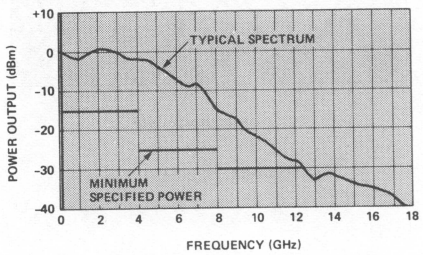


Figure 7. Spectrum Envelope of 33002A/B (100 MHz)

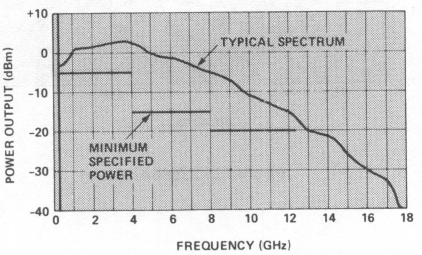


Figure 8. Spectrum Envelope of 33003A/B (250 MHz)

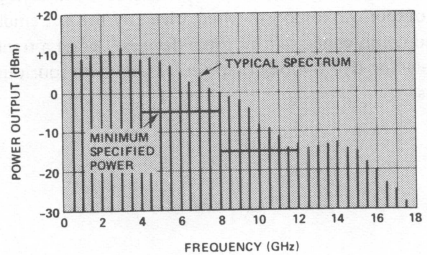


Figure 9. Spectrum Envelope of 33004A/B (500 MHz)

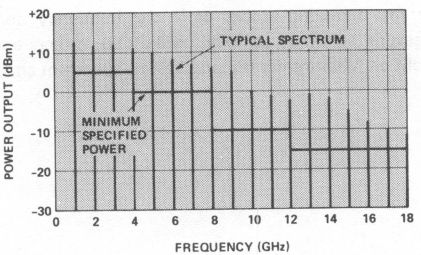


Figure 10. Spectrum Envelope of 33005C/D (1000 MHz)

Specifications at T_{CASE} = 25°C

MAXIMUM RATINGS

Maximum power at input frequency(1) . . . . . 1.0 watts
Maximum operating temperature . . . . . 125°C

Notes: (1) Derate to 0.5W at 125°C.

INPUT SPECIFICATIONS

Model Number	Input Frequency
33002A/B	100 ±5 MHz (useful at slightly reduced performance 100 ±10 MHz)
33003A/B	250 ±12.5 MHz (useful at slightly reduced performance 250 ±25 MHz)
33004A/B	500 ±25 MHz (useful at slightly reduced performance 500 ±50 MHz)
33005C/D	1000 ±50 MHz (useful at slightly reduced performance 1000 ±100 MHz)
Input SWR For All Models	Less than 2:1 at center frequency

TYPICAL OUTPUT PULSE CHARACTERISTICS, 0.5 WATT DRIVE

Model Number (Drive Frequency)	Pulse Height (V) Typ.	Pulse Width (ps) Typ.
33002A/B (100 MHz)	15	130
33003A/B (250 MHz)	15	130
33004A/B (500 MHz)	15	130
33005C/D (1000 MHz)	10	130

LINE SPECTRA, 0.5 WATT DRIVE

Model Number	Power Output per Line (dBm)							
	f_{in}* to 4 GHz		4-8 GHz		8-12.4 GHz		12.4-18 GHz	
	Min.	Typ.†	Min.	Typ.†	Min.	Typ.†	Min.	Typ.†
33002A/B (100 MHz)	-15	-5	-25	-15	-30	-25	-	-35
33003A/B (250 MHz)	-5	0	-15	-5	-20	-15	-	-30
33004A/B (500 MHz)	+5	+10	-5	+5	-15	-5	-	-15
33005C/D (1000 MHz)	+5	+10	0	+5	-10	0	-15	-5

*Fundamental line excluded. †Midband, see figures 7-10.

MECHANICAL CHARACTERISTICS

Size . . . . . See outline drawing
Weight . . . . . 10 grams
Materials . . . . . Outer case, Kovar; connectors, stainless steel
Finish B and D versions . . . . . Gold plated, 50 microinch minimum
A and C versions . . . . . Stainless steel

TEMPERATURE EFFECTS

The comb generator is designed to operate over wide ambient temperatures (−55°C to +125°C). The SWR remains below 2:1 and typical spectral line power variation is about ±2 dB over this temperature range.

BIAS

The circuit diagrams are shown in Figure 1. The "A" and "C" versions are complete comb generators with DC return and require no external bias. The module ("B" and "D" versions, no connectors) can be biased from either end by using a bias tee.

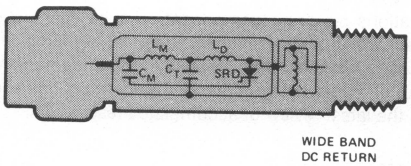


Figure 1a. Electrical Schematic of "A" and "C" Versions

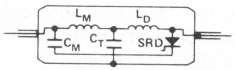
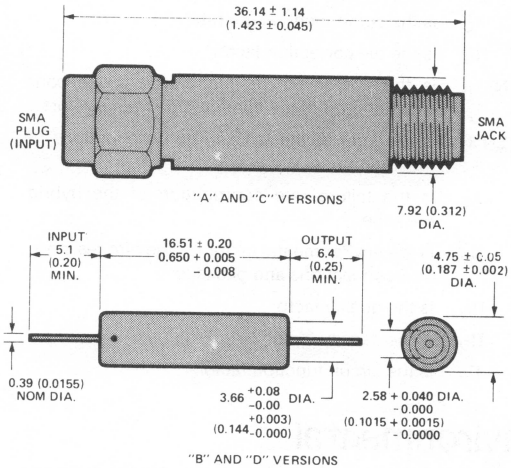


Figure 1b. Electrical Schematic of "B" and "D" Versions

ENVIRONMENTAL CHARACTERISTICS

Temperature Storage . . . . . −55°C to +125°C
Temperature Operating . . . . . −55°C to +125°C
Temperature Cycling . . . . . MIL-STD-750, Method 1051 Test Condition A
Temperature Shock . . . . . MIL-STD-750, Method 1056 Test Condition A ("B" and "D" versions only)
Moisture Resistance . . . . . MIL-STD-750, Method 1021
Shock (nonoperating) . . . . . MIL-STD-750, Method 2016 5 blows each X_1, Y_1, Y_2 orientations 0.5ms, 1500 g's
Vibration Fatigue . . . . . MIL-STD-750, Method 2046



ALL DIMENSIONS ARE IN MILLIMETERS AND (INCHES).
TOLERANCES UNLESS OTHERWISE SPECIFIED:
X.X = 0.5 (0.020) X.XX = 0.13 (0.005)
●BLACK DOT INDICATES INPUT SIDE

Figure 2. Mechanical Outlines

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RELIABILITY DATA COMB GENERATORS

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests to demonstrate that a product meets design criteria. The data on this sheet represents the latest review of accumulated test results.

Reliability

Each design is tested for performance under varying conditions of temperature, humidity, vibration and mechanical shock. Sample production units undergo life testing to demonstrate predicted MTTF for selected product designs.

The following MTTF (Mean Time To Failure) hours have been calculated from the failure rate predictions found in MIL-HDBK-217D, Reliability Prediction of Electronic Equipment. The Hybrid Microcircuit failure rate model was used:

$$\lambda_p = \left\{ \Sigma N_C \lambda_C \Pi_G + [N_R \lambda_R + \Sigma N_I \lambda_I + \lambda_S] \Pi_F \Pi_E \right\} \Pi_Q \Pi_D$$

(failures/10^6 hour)

where:

$$MTTF = 1/\lambda_p$$

$\Sigma N_C \lambda_C \Pi_G$ is the sum of the adjusted failure rates for the active components, packaged resistors, and capacitors in the hybrid

N_C is the number of each particular component

λ_C is the component failure rate

Π_G is the die correction factor

$N_R \lambda_R$ is the number of (N_R) and failure rate contribution (λ_R) of the chip or substrate resistors

$\Sigma N_I \lambda_I$ is the sum of the failure rate contributions of the interconnections (λ_I)

λ_S is the failure rate contribution of the hybrid package

Π_E is the environmental factor for the film resistors, interconnections and package

Π_Q is the quality factor

Π_D is the density factor

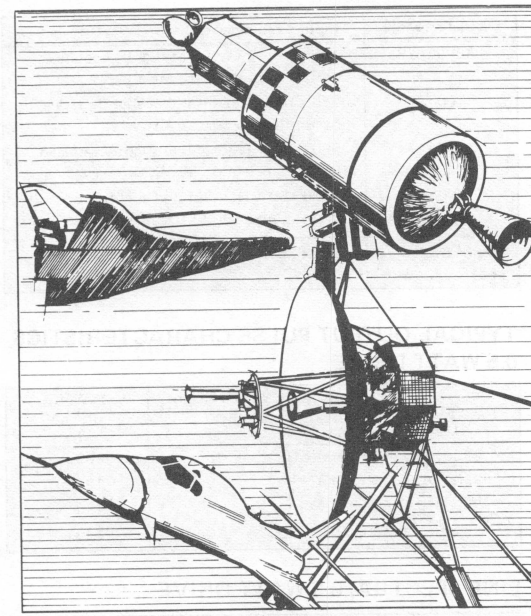
Π_F is the circuit function factor

Environmental

Two common environments were chosen for the following MTTF predictions:

Ground, Benign (GB) at 25°C ambient temperature

—Nonmobile, laboratory environment readily accessible to maintenance; includes laboratory instruments and test equipment, medical electronic equipment, business and scientific computer complexes.



Ground, Fixed (GF) at 40°C ambient temperature

—Conditions less than ideal such as installation in permanent racks with adequate cooling air and possible installation in unheated buildings; includes permanent installation of air traffic control, radar and communications facilities, and missile silo ground support equipment.

MTTF Summary

Part Number	Environment	Ambient Temperature	MTBF Hours
33002A	G_F	50°C	3.67×10^6
33002B	G_B	25°C	14.22×10^6
33002B	G_F	50°C	4.63×10^6
33003A	G_F	50°C	3.67×10^6
33003B	G_B	25°C	14.22×10^6
33003B	G_F	50°C	4.63×10^6
33004A	G_F	50°C	3.67×10^6
33004B	G_B	25°C	14.22×10^6
33004B	G_F	50°C	4.63×10^6
33005C	G_F	50°C	3.67×10^6
33005D	G_B	25°C	14.22×10^6
33005D	G_F	50°C	4.63×10^6

ABSTRACTS OF APPLICATION NOTES COMB GENERATORS

The Microwave Semiconductor Division field sales force is supported by a division applications staff. These technical specialists investigate circuit applications of most interest to the users of these semiconductor devices. The results of these investigations are reported in application notes or in brief application bulletins.

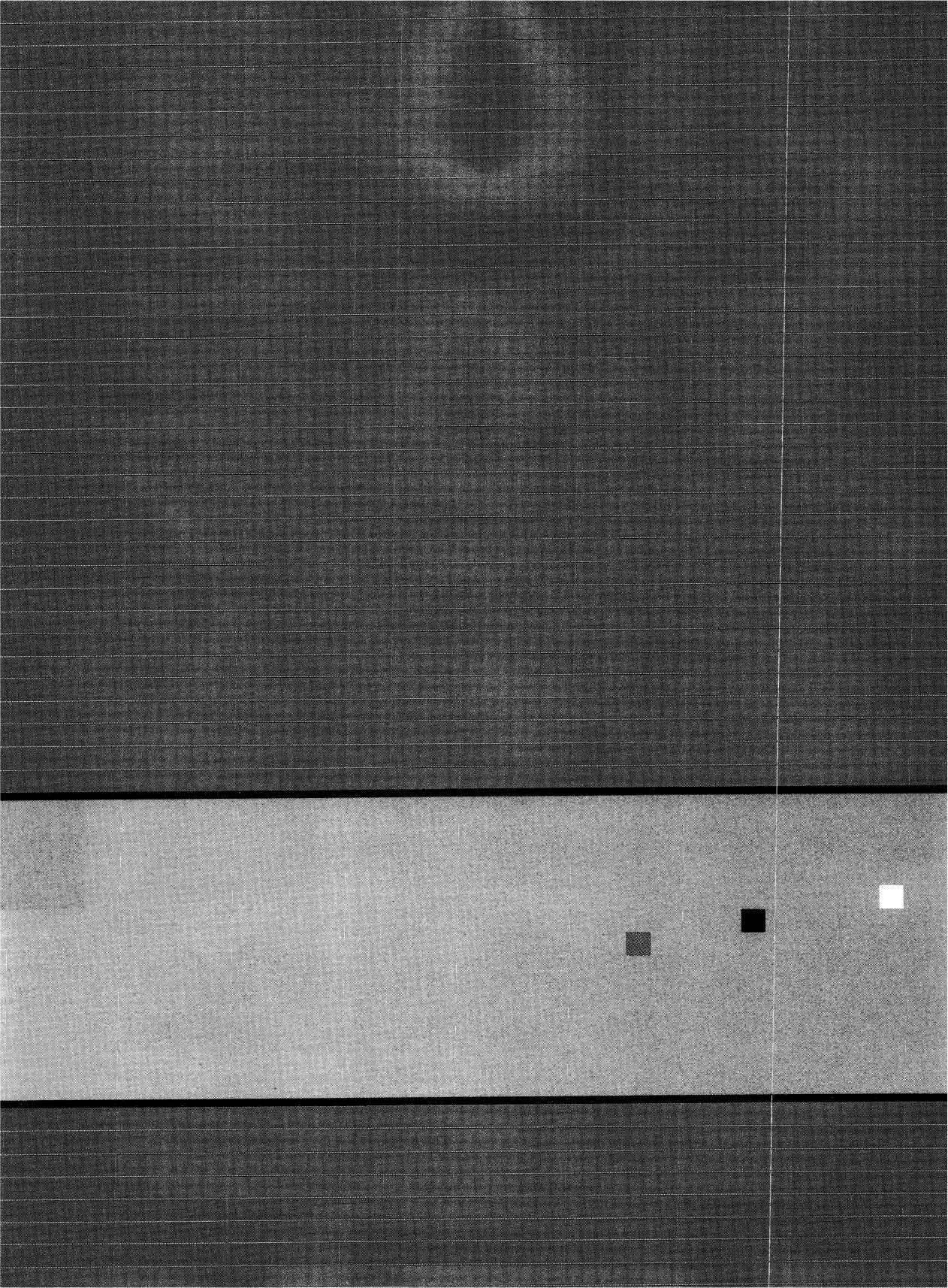
A complete list with brief abstracts is presented here. Below is a brief summary of Application Notes for Comb Generators. All of the Application Notes are available from your local HP Sales Office or nearest HP Components Authorized Distributor or Representative.

983 Comb Generator Simplifies Multiplier Design

Comb generators are often used with bandpass filters to form frequency multipliers. This note discusses this application for the particular case of a bandpass filter passing several frequencies in the comb. The presence of the filter increases the power output by an amount related to the spacing between the filter and the diode.

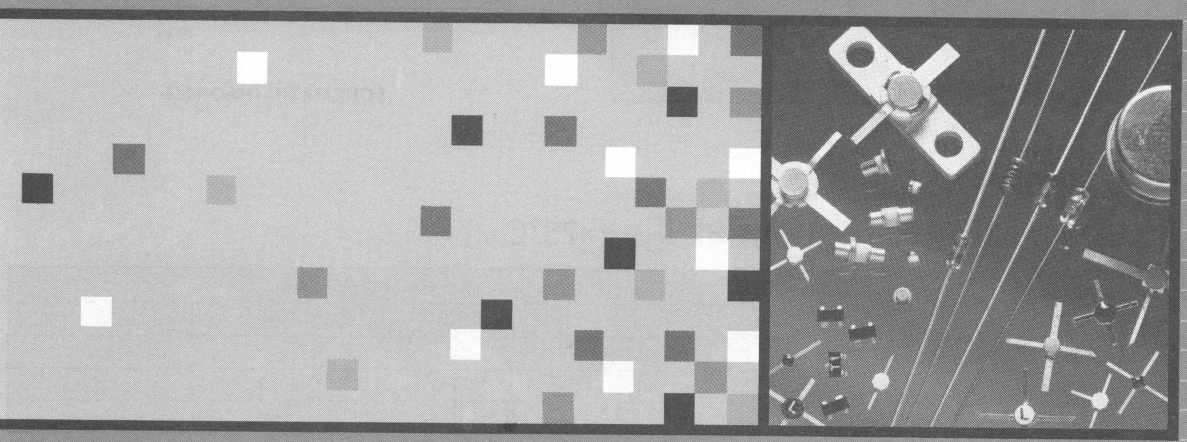
984 How to Get More Power from a Comb Generator Module with the Right Bias Resistance

This note shows how to improve the power output at all frequencies in the comb. The modules do not contain a DC return for the bias current produced by rectification in the step recovery diode. AN 984 discusses the proper choice of bias resistor to double the power output compared to a DC short circuit.



Broadband DC Return

- Microwave Bias Network (Broadband DC Return) 0.1-18 GHz 13-2
- Reliability Data 13-4



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MICROWAVE BIAS NETWORK 0.1-18 GHz

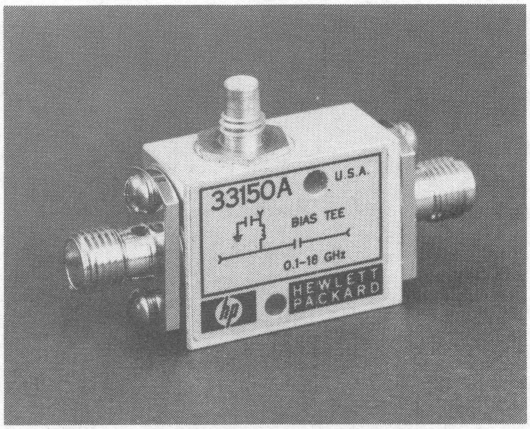
33150A

Features

WIDEBAND

LOW INSERTION LOSS

HIGH RF TO DC ISOLATION

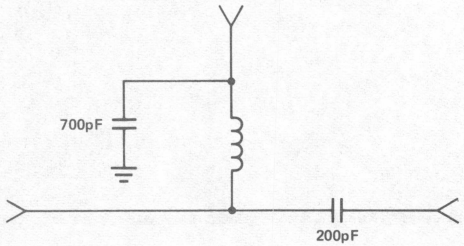


Description

This broadband DC return is designed for use as a bias tee or DC return in microwave laboratory and systems applications. Examples of microwave bias applications include FET or Bipolar transistor amplifiers, SRD multipliers, mixers and detectors, and limiters. This device is ideal for use in device and circuit test setups in the laboratory, where minimum disturbance of the RF circuit is desired.

Maximum Ratings

Parameter	Total
Operating Temperature	-65°C to +95°C
Storage Temperature	-65°C to +125°C
Bias Voltage	100V
Bias Current	200mA



SCHEMATIC DIAGRAM

Electrical Specifications at T_{CASE} = 25°C

Parameter	Frequency Range (GHz)			
	0.1-3.5	3.5-11	11-18	18-26 Option 002
Maximum Insertion Loss (dB)	0.4	0.6	1.1	1.5
Maximum SWR	1.5:1	1.5:1	1.8:1	2.8:1
Maximum DC Bias Resistance (Ω)	4.0			

Ordering Information

The 33150 is a broadband bias network. The standard unit is supplied with SMA jack (female), RF connectors, and SMC jack (male) bias connector. An SMA jack bias connector is available as Option 001.

Mechanical Specifications

Body: Alodined aluminum, MIL-C-5541.

Maximum Weight: 23 grams (.8 ounces)

Environmental Ratings

Non-Operating Temperature Cycling: MIL-STD-883, Method 1010. Test Condition B (-55°C to +125°C).

Shock: MIL-STD-883. Method 2002. Test Condition B, (0.5ms, 1500G).

Moisture Resistance: MIL-STD-883. Method 1004.

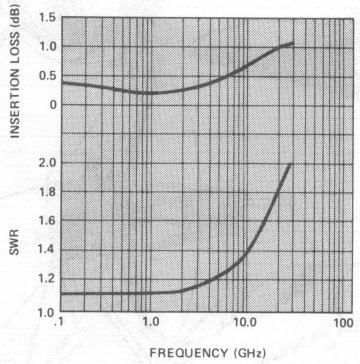


Figure 1. Typical Insertion Loss and SWR.

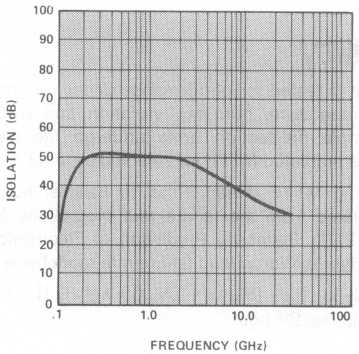
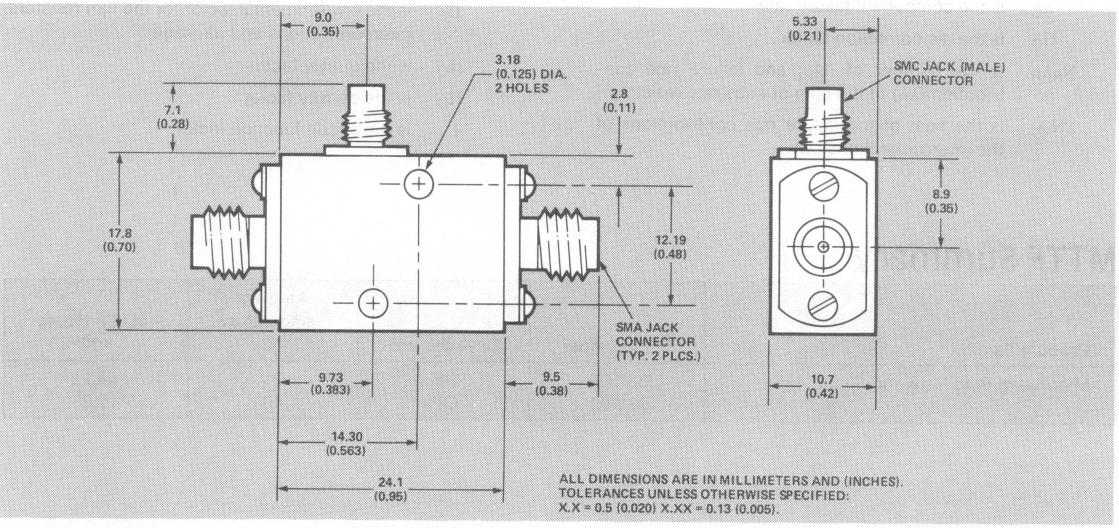


Figure 2. Typical RF to DC Isolation.

Outline Drawing

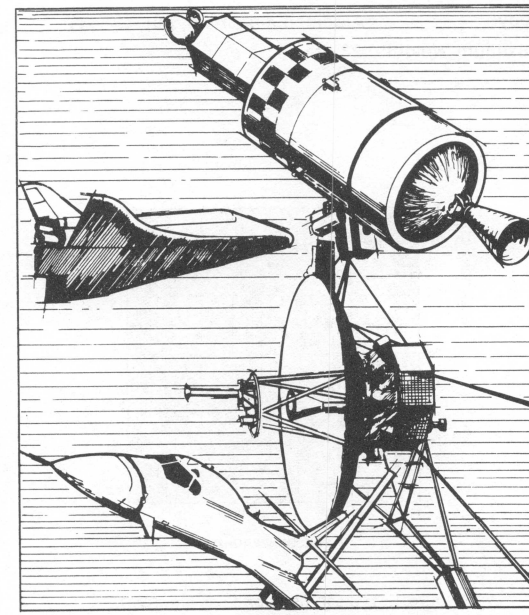


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RELIABILITY DATA
BROADBAND DC RETURN

Description

For applications requiring component reliability estimation, Hewlett-Packard provides reliability data for all families of devices. Data is compiled from reliability tests to demonstrate that a product meets design criteria. The data on this sheet represents the latest review of accumulated test results.



Reliability

Each design is tested for performance under varying conditions of temperature, humidity, vibration and mechanical shock. Sample production units undergo life testing to demonstrate predicted MTTF for selected product designs.

The following MTTF (Mean Time To Failure) hours have been calculated from the failure rate predictions found in MIL-HDBK-217D, Reliability Prediction of Electronic Equipment. The Hybrid Microcircuit failure rate model was used:

$$\lambda_p = \left\{ \Sigma N_C \lambda_C \Pi_G + [N_R \lambda_R + \Sigma N_I \lambda_I + \lambda_S] \Pi_F \Pi_E \right\} \Pi_Q \Pi_D$$

(failures/10^6 hour)

where:

$MTTF = 1/\lambda_p$

$\Sigma N_C \lambda_C \Pi_G$ is the sum of the adjusted failure rates for the active components, packaged resistors, and capacitors in the hybrid

N_C is the number of each particular component

λ_C is the component failure rate

Π_G is the die correction factor

$N_R \lambda_R$ is the number of (N_R) and failure rate contribution (λ_R) of the chip or substrate resistors

$\Sigma N_I \lambda_I$ is the sum of the failure rate contributions of the interconnections (λ_I)

λ_S is the failure rate contribution of the hybrid package

Π_E is the environmental factor for the film resistors, interconnections and package

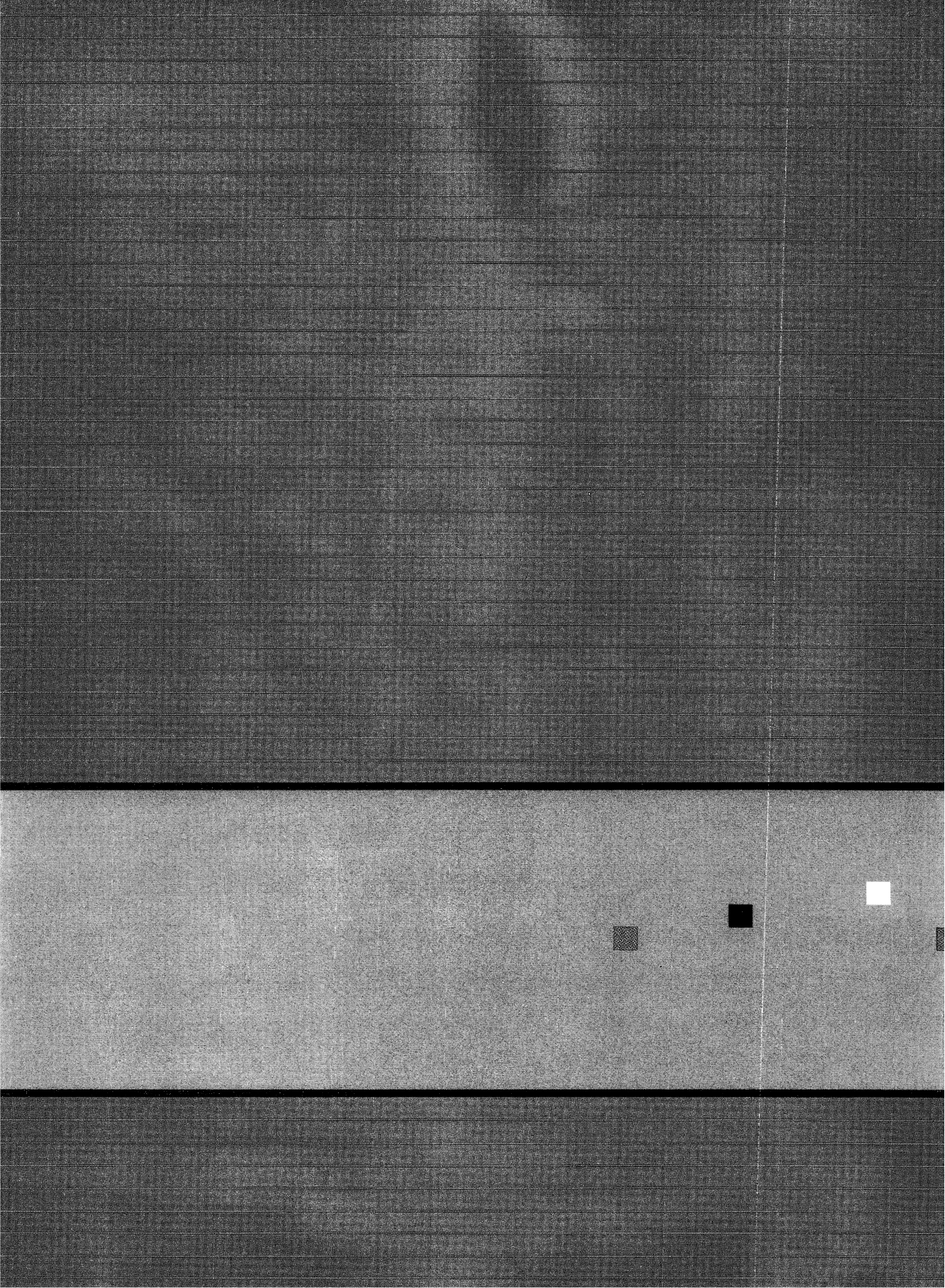
Π_Q is the quality factor

Π_D is the density factor

Π_F is the circuit function factor

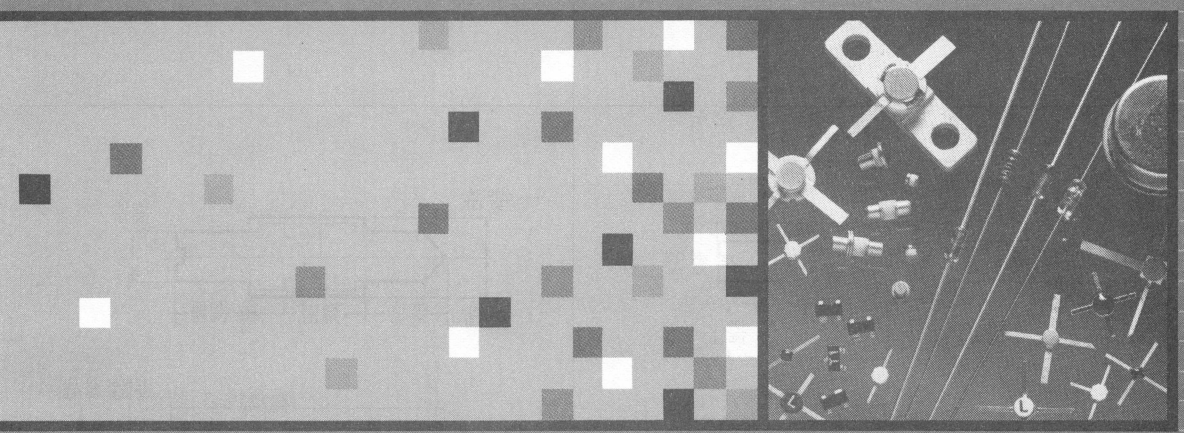
MTTF Summary

Product Family	Part Number	Environment	Ambient Temperature °C	MTTF Hours × 10^6
Microwave Bias Network	33150A	GB	25	54.22
	33150A	GF	40	22.23



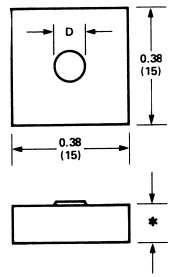
Appendix

- Package Outlines 14-2
- Authorized Distributor and Representative Directory 14-8
- Sales and Support Offices 14-12



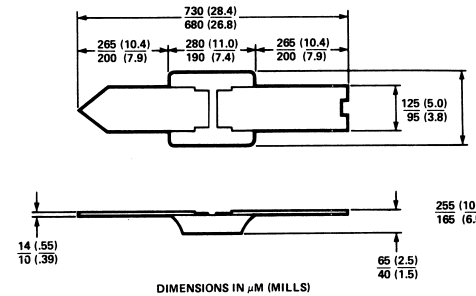
PACKAGE OUTLINES

All dimensions in millimeters (inches), except where noted.
For complete package specifications refer to individual product specification sheets.
Drawings are not to scale.

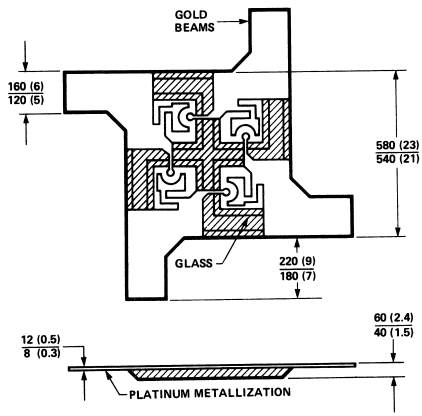


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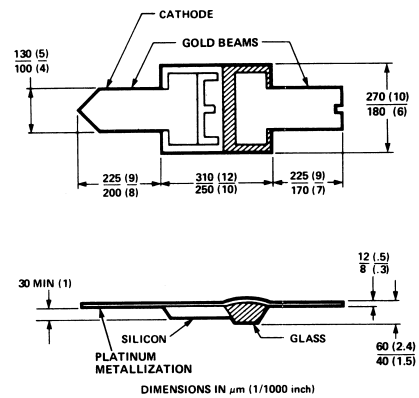
*See data sheet for center junction, off-set junction and nine-point contact.



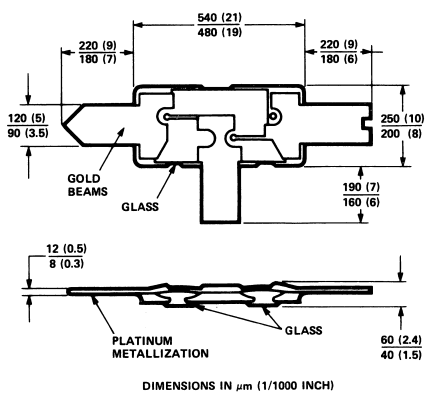
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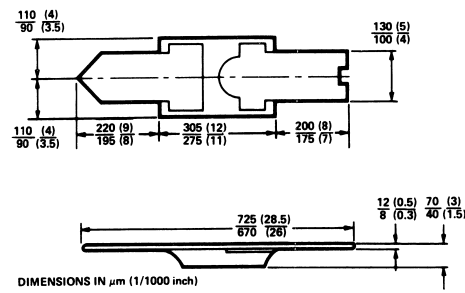
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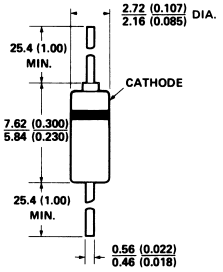


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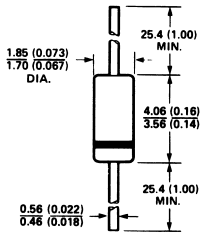


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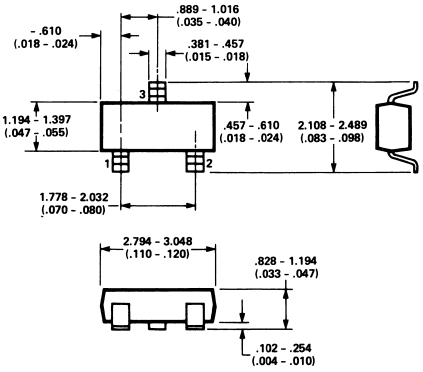
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Drawings are not to scale.



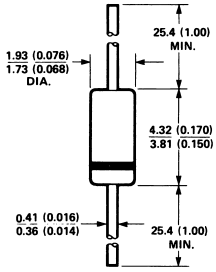
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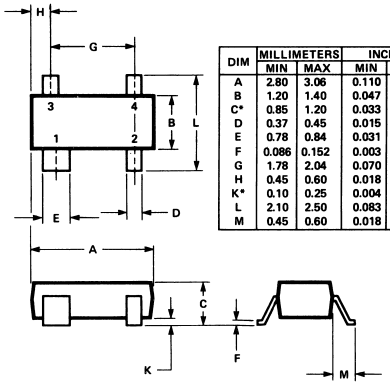
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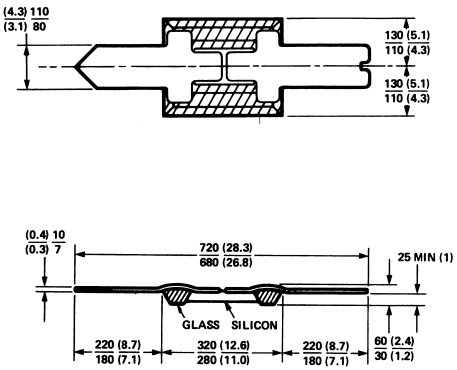


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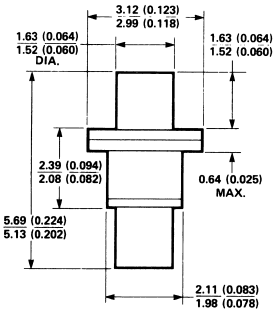


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.06	0.110	0.120
B	1.20	1.40	0.047	0.055
C*	0.85	1.20	0.033	0.047
D	0.37	0.45	0.015	0.018
E	0.78	0.84	0.031	0.033
F	0.086	0.152	0.003	0.006
G	1.78	2.04	0.070	0.080
H	0.45	0.60	0.018	0.024
K*	0.10	0.25	0.004	0.010
L	2.10	2.50	0.083	0.098
M	0.45	0.60	0.018	0.024

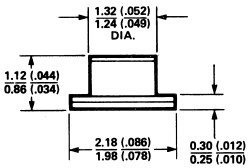
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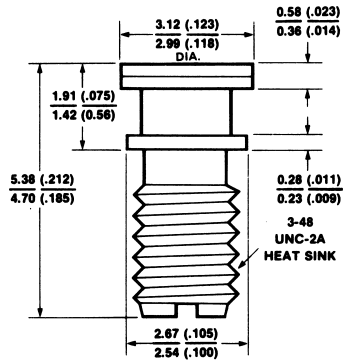


31

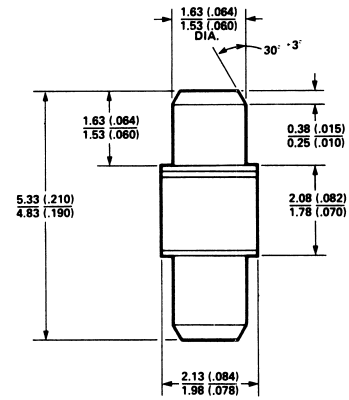


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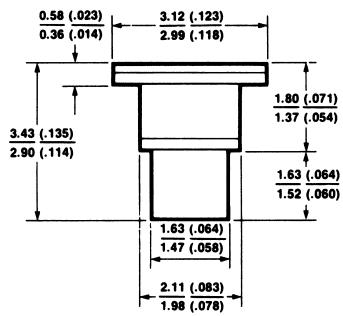
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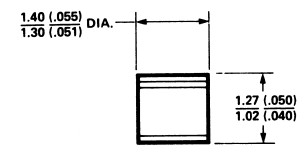
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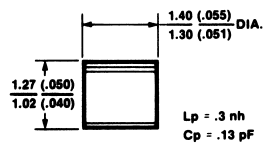
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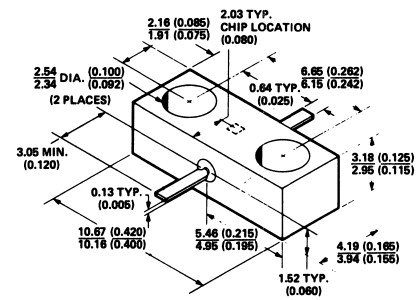
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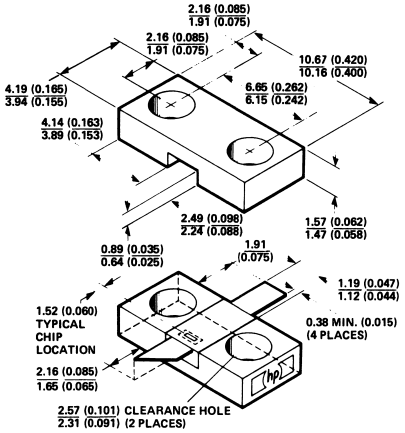


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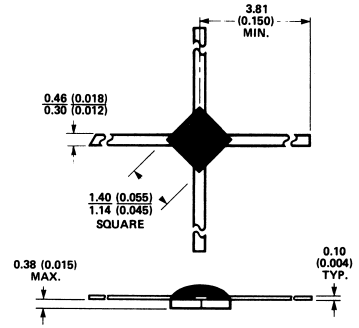


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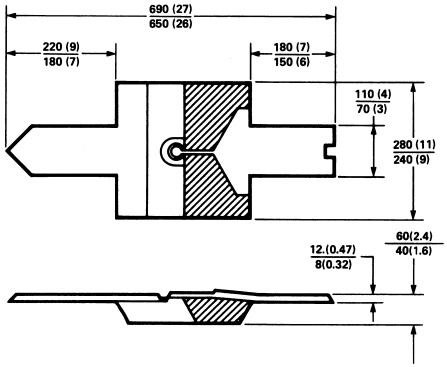
All dimensions in millimeters (inches), except where noted.
For complete package specifications refer to individual product specification sheets.
Drawings are not to scale.



61

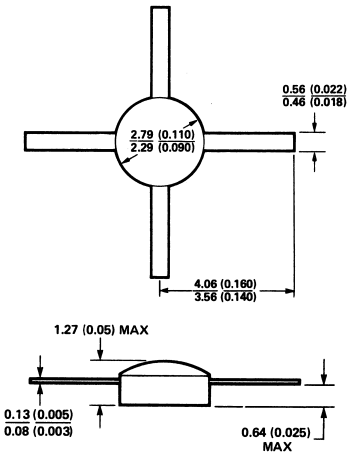


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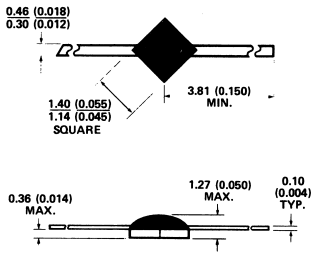


DIMENSIONS IN μm (1/1000 INCH)

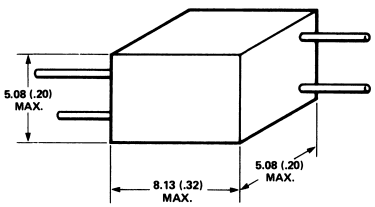
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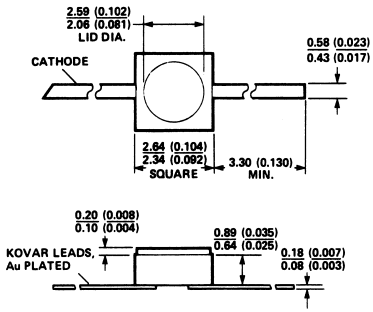
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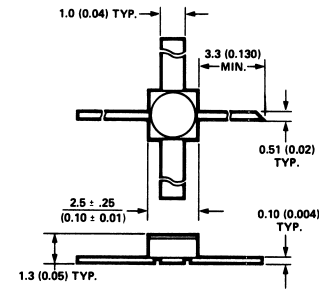
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G1/G2

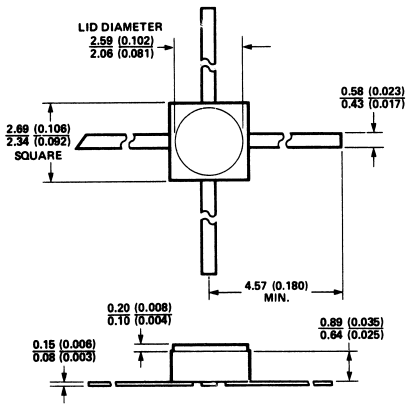
All dimensions in millimeters (inches), except where noted.
For complete package specifications refer to individual product specification sheets.
Drawings are not to scale.



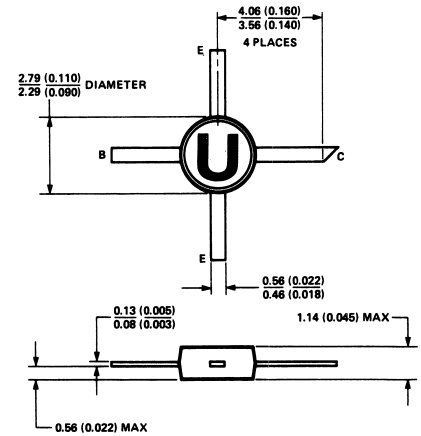
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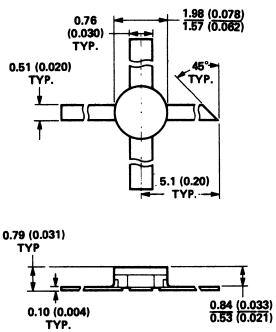
HPAC-100



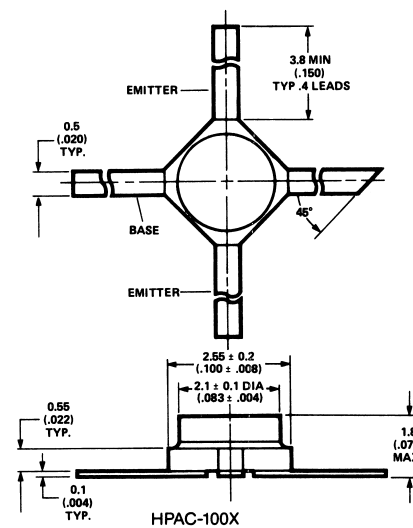
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HPAC-100P

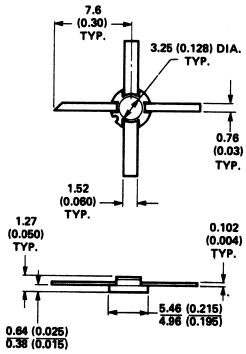


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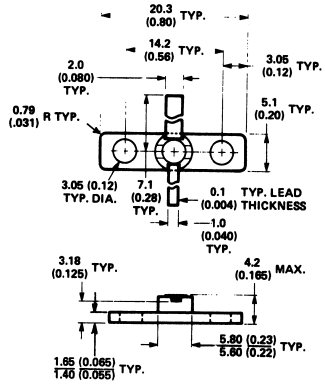


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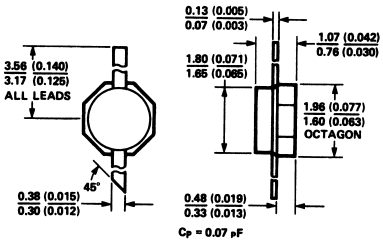
All dimensions in millimeters (inches), except where noted.
For complete package specifications refer to individual product specification sheets.
Drawings are not to scale.



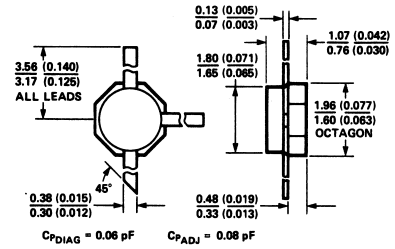
HPAC-200



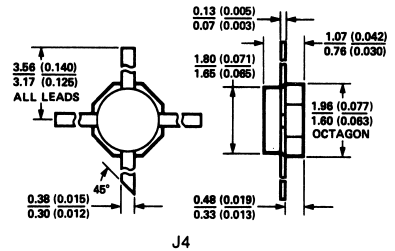
HPAC-200 GB/GT



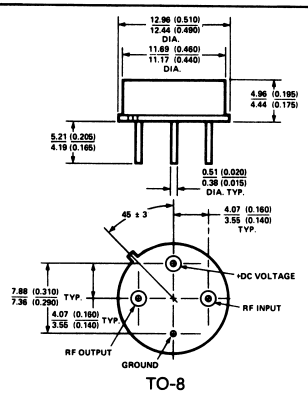
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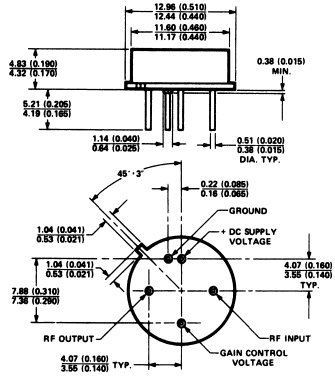
J3



J4



TO-8



TO-8a

HP Components Authorized Distributor and Representative Directory

United States

Alabama

Hall-Mark Electronics
4900 Bradford Drive
Huntsville 35807
(205) 837-8700

Hamilton/Avnet
4940 Research Drive N.W.
Huntsville 35805
(205) 837-7210

Schweber Electronics
4910 Corporate Drive, Suite J
Huntsville 35805
(205) 895-0480

Arizona

Hamilton/Avnet
505 South Madison
Tempe 85281
(602) 231-5100

Schweber Electronics
11049 N. 23rd. Drive
Suite 100
Phoenix 85029
(602) 997-4874

California

Avnet Electronics
350 McCormick Avenue
Costa Mesa 92626
(714) 754-6111

Hall-Mark Electronics
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(818) 716-7300

Hall-Mark Electronics
6341 Auburn Blvd., Suite D
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(916) 722-8600

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Hall-Mark Electronics
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Hamilton/Avnet
9650 De Soto Avenue
Chatsworth 91311
(818) 700-6565

California (cont.)

Hamilton/Avnet
Southwest Regional
Stocking Center
350 McCormick Avenue
Costa Mesa, CA 92626
(714) 754-6100

Hamilton/Avnet (Corp)
10950 W. Washington Blvd.
Culver City 90230
(213) 558-2020

Hamilton/Avnet
3002 East G Street
Ontario 91764
(714) 989-4602

Hamilton/Avnet
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Sacramento 95834
(916) 925-2216

Hamilton/Avnet
4545 Viewridge Avenue
San Diego 92123
(619) 571-7510

Hamilton/Avnet
1175 Bordeaux Drive
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(408) 743-3300

Hamilton Electro Sales
3170 Pullman Street
Costa Mesa 92626
(714) 641-4100

Hamilton Electro Sales
1361 "B" West 190th Street
Gardena 90248
(213) 217-6700

Schweber Electronics
21139 Victory Blvd.
Canoga Park 91303
(818) 999-4702

Schweber Electronics
1225 W. 190th Street
Suite 360
Gardena 90248
(213) 327-8409

Schweber Electronics
17822 Gillette Avenue
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(714) 863-0200

Schweber Electronics
1771 Tribute Road
Suite B
Sacramento 95815
(916) 929-9732

Schweber Electronics
6750 Nancy Ridge Drive
Bldg. 7, Suites D & E
San Diego 92121
(619) 450-0454

California (cont.)

Schweber Electronics
90 East Tasman Drive
San Jose 95134
(408) 946-7171

Colorado

Hamilton/Avnet
8765 East Orchard
Suite 708
Englewood 80111
(303) 740-1000

Schweber Electronics
8955 E. Nichols Avenue
Suite 200
Englewood 80112
(303) 799-0258

Connecticut

Hall-Mark Electronics
Barnes Industrial Park
33 Village Lane
P.O. Box 5024
Wallingford 06492
(203) 269-0100

Hamilton/Avnet
Commerce Drive
Commerce Industrial Park
Danbury 06810
(203) 797-2800

Schweber Electronics
Finance Drive
Commerce Industrial Park
Danbury 06810
(203) 748-7080

Florida

Hall-Mark Electronics
15301 Roosevelt Blvd.
Suite 303
Clearwater 33520
(813) 530-4543

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7648 Southland Blvd.
Suite 100
Orlando 32809
(305) 855-4020

Hall-Mark Electronics
3161 S.W. 15th Street
Pompano Beach 33069-4800
(305) 971-9280

Hamilton/Avnet
6801 N.W. 15th Way
Ft. Lauderdale 33309
(305) 971-2900

Hamilton/Avnet
3197 Tech Drive North
St. Petersburg 33702
(813) 576-3930

Florida (cont.)

Hamilton/Avnet
6947 University Blvd.
Winter Park 32792
(305) 628-3888

Schweber Electronics
317 S. North Lake Blvd.
Suite 1024
Altamonte Springs 31701
(305) 331-7555

Schweber Electronics
3665 Park Central Blvd. North
Building #6
Pompano Beach 33064
(305) 977-7511

Georgia

Hall-Mark Electronics
6410 Atlantic Boulevard
Suite 115
Norcross 30071
(404) 447-8000

Hamilton/Avnet
5825 D. Peachtree Corners East
Norcross 30092
(404) 447-7507

Schweber Electronics
303 Research Drive
Suite 210
Norcross 30092
(404) 449-9170

Illinois

Hall-Mark Electronics
210 Mittel Drive
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Hamilton/Avnet
1130 Thorndale Avenue
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Schweber Electronics
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Elk Grove Village 60007
(312) 364-3750

Indiana

Hall-Mark Electronics
4275 W. 96th Street
Indianapolis 46268
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Carmel 46032
(317) 844-9333

Iowa

Hamilton/Avnet
915 33rd Avenue S.W.
Cedar Rapids 52404
(319) 362-4757

Schweber Electronics
5270 North Park Place N.E.
Cedar Rapids 52402
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Kansas

Hall-Mark Electronics
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(913) 888-4747

Hamilton/Avnet
9219 Quivira Road
Overland Park 66215
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Schweber Electronics
10300 W. 103rd. Street
Suite 200
Overland Park 66214
(913) 492-2922

Maryland

Hall-Mark Electronics
10240 Old Columbia Road
Columbia 21046
(301) 988-9800

Hamilton/Avnet
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Hall-Mark Electronics
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Hamilton/Avnet
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Bedford 01730
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Hamilton/Avnet
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Grand Rapids 49508
(616) 243-8805

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Livonia 48150
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Schweber Electronics
12060 Hubbard Drive
Livonia 48150
(313) 525-8100

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Hall-Mark Electronics
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Suite 101
Eden Prairie 55344
(612) 941-2600

Hamilton/Avnet
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Minnetonka 55343
(612) 932-0600

Schweber Electronics
7424 W. 78th Street
Edina 55435
(612) 941-5280

Missouri

Hall-Mark Electronics
13750 Shoreline Drive
Earth City 63045
(314) 291-5350

Hamilton/Avnet
13743 Shoreline Court
Earth City 63045
(314) 344-1200

Schweber Electronics
502 Earth City Expwy.
Suite 203
Earth City, 63045
(314) 739-0526

New Hampshire

Hamilton/Avnet
444 East Industrial Park Dr.
Manchester 03103
(603) 624-9400

Schweber Electronics
Bedford Farms, Bldg. 2
Kilton & South River Road
Manchester 03102
(603) 625-2250

New Jersey

Hall-Mark Electronics
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Fairfield 07006
(201) 575-4415

Hall-Mark Electronics
1000 Midlantic Drive
Mt. Laurel 08054
(609) 235-1900

Hamilton/Avnet
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Cherry Hill 08003
(609) 424-0100

Hamilton/Avnet
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Schweber Electronics
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New Mexico

Hamilton/Avnet
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Albuquerque 87106
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Hall-Mark Electronics
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(516) 737-0600

Hamilton/Avnet
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Hauppauge 11788
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Hamilton/Avnet
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Hamilton/Avnet
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Syracuse 13206
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Schweber Electronics
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Rochester 14623
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Schweber Electronics
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Westbury 11590
(516) 334-7474

North Carolina

Hall-Mark Electronics
5237 North Boulevard
Raleigh 27604
(919) 872-0712

Hamilton/Avnet
3510 Spring Forest Road
Raleigh 27604
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Schweber Electronics
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5285 North Boulevard
Raleigh 27604
(919) 876-0000

Ohio

Hall-Mark Electronics
5821 Harper Road
Solon 44139
(216) 349-4632

Hall-Mark Electronics
400 E. Wilson Bridge Rd.
Suite S
Worthington 43085
(614) 888-3313

Hamilton/Avnet
4588 Emery Industrial Parkway
Cleveland 44128
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Dayton 45459
(513) 439-6700

Hamilton/Avnet
777 Brooksedge Blvd.
Westerville 43081
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Beachwood 44122
(216) 464-2970

Ohio (cont.)

Schweber Electronics
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Dayton 45459
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Hamilton/Avnet
12121 E. 51st Street
Suite 102A
Tulsa 74146
(918) 252-7297

Schweber Electronics
4815 S. Sheridan
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Tulsa 74145
(918) 622-8000

Oregon

Almac Electronics
1885 N.W. 169th Place
Beaverton 97006-4849
(503) 629-8090

Hamilton/Avnet
6024 S.W. Jean Road
Bldg. C, Suite 10
Lake Oswego 97034
(503) 635-8831

Pennsylvania

Hamilton/Avnet
2800 Liberty Avenue
Pittsburgh 15222
(412) 281-4150

Schweber Electronics
900 Business Center Dr.
Horsham 19044
(215) 441-0600

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1000 R.I.D.C. Plaza
Suite 203
Pittsburgh 15238
(412) 782-1600

Texas

Hall-Mark Electronics (Corp.)
11333 Pagemill Drive
Dallas 75234
(214) 343-5000

Hall-Mark Electronics
12211 Technology Blvd.
Austin 78727
(512) 258-8848

Hall-Mark Electronics
10375 Brockwood Road
Dallas 75238
(214) 553-4300

Hall-Mark Electronics
8000 Westglen
Houston 77063
(713) 781-6100

Hamilton/Avnet
1807A West Braker Lane
Austin 78758
(512) 837-8911

Hamilton/Avnet
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Stafford 77477
(713) 240-7733

Hamilton/Avnet
2111 W. Walnut Hill Lane
Irving 75038
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Suite 240
Austin 78752
(512) 458-8253

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Schweber Electronics
10625 Richmond Avenue
Suite 100
Houston 77042
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Utah

Hamilton/Avnet
1585 West 2100 South
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(801) 972-2800

Washington

Almac Electronics
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(206) 643-9992

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Hamilton/Avnet
14212 N.E. 21st Street
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Wisconsin

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New Berlin 53151
(414) 797-7844

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New Berlin 53151
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Schweber Electronics
3050 South Calhoun
New Berlin 53151
(414) 784-9020

International

Australia

VSI Electronics Pty. Ltd.
Office 4
116 Melbourne Street
North Adelaide
South Australia 5006
(61) 8 267 4848

VSI Electronics Pty. Ltd.
Suite 3, Bell Court
Cnr. Water & Brunswick Sts
Fortitude Valley
Brisbane, Queensland 4006
(61) 7 52 5022

VSI Electronics Pty. Ltd.
Unit 1
25 Brisbane Street
East Perth, W.A. 6000
(61) 9 328 8499

VSI Electronics Pty. Ltd.
16 Dickson Avenue
Artarmon, N.S.W. 2064
(61) 2 439 8622

VSI Electronics Pty. Ltd.
6/417 Ferntree Gully Road
Mt. Waverley
Melbourne, Victoria 3149
(61) 3 543 6445

Austria

Transistor V.m.b.H
Auhofstr. 41a
A-1130 Wien
(43) 222 829451

Belgium

Diode Belgium
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Rue De L'Aeronef 2
B-1140 Brussels
(32) 2 216 2100

Brazil

Dataronix Electronics LTDA
c/o MC-Microcircuits Ctd.
Rua Madeira, 42 - Caninde
03033 - Sao Paulo
(55) 11 2285911

Canada

Hamilton/Avnet Electronics Ltd.
2550 Boundary Road, Suite 115
Burnaby, BC V5M 3Z3
(604) 437-6667

Hamilton/Avnet Electronics Ltd.
2816 21st Street NE
Calgary, Alberta T2E 6Z2
(403) 250-9380

Hamilton/Avnet
Electronics Ltd.
6845 Rexwood Drive
Units 3, 4 & 5
Mississauga, Ontario L4V 1R2
(416) 677-7432

Hamilton/Avnet
Electronics Ltd.
2795 Halpern Street
St. Laurent
Montreal, Quebec H4S 1P8
(514) 335-1000

Hamilton/Avnet
Electronics Ltd.
190 Colonnade Road
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(613) 226-1700

Hi-Tech Sales Limited (REP)
Box 115
339 10th Avenue S.E.
Calgary, Alberta T2G 0W2
(403) 239-3773

Hi-Tech Sales Limited (REP)
7510B Kingsway
Burnaby, B.C. V3N 3C2
(604) 524-2131

Canada (cont.)

Hi-Tech Sales Limited (REP)
102-902 St. James Street
Winnipeg, Manitoba R3G 3J7
(204) 786-3343

Zentronics, Ltd.
8 Tilbury Court
Brampton, Ontario L6T 3T4
(416) 451-9600

Zentronics, Ltd.
Bay #1
3300 14th Avenue, N.E.
Calgary, Alberta T2A 6J4
(403) 272-1021

Zentronics, Ltd.
155 Colonnade Road
Units 17 & 18
Nepean, Ontario K2E 7K1
(613) 226-8840

Zentronics, Ltd.
817 McCaffrey Street
Ville St. Laurent
Montreal, Quebec H4T 1N3
(514) 737-9700

Zentronics, Ltd.
Unit 108
11400 Bridgeport Road
Richmond, B.C. V6X 1T2
(604) 273-5575

Zentronics, Ltd.
546 Weber St. N.
Unit 10
Waterloo, Ontario N2L 5C6
(519) 884-5700

Zentronics, Ltd.
93-1313 Border Street
Winnipeg, Manitoba R3H 0X4
(204) 775-8661

China
(Peoples Republic of China)

China HP Rep Office
4th Floor, 2nd Watch Factory
Shuang Yu Shu
Bei San Huan Lu
Hai-Dian District, Beijing
(560) 280-567

Denmark

Interelko A/S
Silovej 18
DK-2690 Karlslunde
(45) 3 140700

Finland

Field-OY
Veneentekijantie 18
SF-00210 Helsinki 21
(358) 0 6922577

France

Almex
Zone Industrielle d'Antony
48, rue de l'Aubepine
92160 Antony
(33) 1 6662112

F. Feutrier
8, Benoit Malon
F-92150 Surensnes
(33) 1 7724646

F. Feutrier
Rue des Trois Glorieuses
42271 St. Priest En Jarez
(33) 7 7746733

S.C.A.I.B.
80 rue d'Arceuil
Zone Silic 137
94523 Rungis Cedex
(33) 1 6872313

Germany

Distron GmbH
Behaimstrasse 3
D-1000 Berlin 10
(49) 30 3421041

EBV-Elektronik
Oberweg 6
D-8025 Unterhaching
Munich
(49) 89 611051

Ingenieurbuero Dreyer
Flensburger Strasse 3
D-2380 Schleswig
(49) 4621 23121

Jermyn GmbH
Postfach 1180
D-6277 Bad Camberg
(49) 6434 230

SASCO GmbH
Hermann-Oberth Strasse 16
D-8011 Dutzbrunn
Munich
(49) 89 461 1211

Hong Kong

CET Ltd. (REP)
10/F Hua Hsia Bldg.
64-66 Gloucester Road
(852) 5 200922

India

Blue Star Ltd. (REP)
Sabri Complex 11 Floor
24 Residency Road
Bangalore 560 025
(91) 812-578881

Blue Star Ltd. (REP)
Sahas
414/2 Veer Sarvarkar
Prabhadevi
Bombay 400 025
(91) 22-430-6155

Blue Star Ltd. (REP)
13 Community Centre
New Friends Colony
New Delhi 110 065
(91) 11-633-773

Blue Star Ltd. (REP)
2-2-47/1108 Bolarum Road
Secunderabad 500-003
(91) 842-72057

Israel

Computation & Measurement
Systems. Ltd. (REP)
11 Masad Street
P.O. Box 25089
Tel Aviv
(972) 3 388456

Italy

Celdis Italiana S.p.A.
Via Fratelli Gracchi, 36
I-20092 Cinisello Balsamo
Milano
(39) 2 6120041

Eledra 3S S.p.A.
Viale Elvezia, 18
I-20154 Milano
(39) 2 349751

Japan

Ryoyo Electric Corporation
Meishin Building
1-20-19 Nishiki
Naka-Ku, Nagoya, 460
(81) 52 2030277

Ryoyo Electric Corporation
Taiyo Shoji Building
4-6 Nakanoshima
Kita-Ku, Osaka, 530
(81) 6 4481631

Ryoyo Electric Corporation
Konwa Building
12-22 Tsukiji, 1-Chome
Chuo-Ku, Tokyo
(81) 3 543771

Tokyo Electron Company, Ltd.
Sinjuku-Nomura Building
Tokyo 160
(81) 3 3434411

Korea

Supertek Korea Inc. (REP)
Han Hyo Building
34-2 Yoido-Dong
Youngdungpo-Ku, Seoul
(82) 2 782-9076/8

Malaysia

Dynamar International Ltd.
Lot 3.03, 3rd Floor, Wisma
Esplanade
43, Green Hall, 10200 Penang
(60) 4 377269 or
4 377292

Netherlands

Koning en Hartman
Elektrotechniek BV
Koperwerf 30
2504 AE Den Haag
(31) 70 210101

New Zealand

VSI Electronics Pty. Ltd.
#7 Beasley Ave., Penrose
Auckland
(64) 9593603

VSI Electronics Pty. Ltd.
Box 21-239
Christchurch
(64) 60928

VSI Electronics Pty. Ltd.
P.O. Box 11145
Wellington
(64) 4848922

Norway

HEFRO Electronikk
P.O. Box 6, Haugenstua
N- Oslo 9
(0915) 107300

Singapore

Dynamar International Ltd.
(REP)
12, Lorong Bakar Batu, #05-11
Kolam Ayer Industrial Park
Singapore 1334
(65) 747-6188

So. Africa

Advanced Semiconductor Devices
(Pty) Ltd.
P.O. Box 2944
Johannesburg 2000, S.A.
(27) 11 802-5820

Spain

Diode Espana
Avda. Brasil 5, 1st Planta
Madrid 20
(34) 14553686

Sweden

TRACO AB
Box 103
123 22 Farsta
(46) 8930000

Switzerland

Baerlocher AG
Foerrlibuckstrasse 110
CH-8037 Zurich
(41) 1 429900

Fabrimex Ag
Kirchenweg 5
CH-8032 Zurich
(41) 1 251 2929

Taiwan (Republic of China)

Morrihan International Inc.
9F, No. 176
Fu, Hsing N. Road
Taipei
(886) 2 7151083

United Kingdom

Celdis Ltd.
37-39 Loverock Road
Reading, Berkshire
RG3 1ED
(44) 734 585171

Farnell Electronic
Components Ltd.
Canal Road
Leeds LS12 2TU
(44) 532-636311

Jermyn Distribution
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Otford Road
Sevenoaks, Kent
TN14 5EU
(44) 732 450144

Macro Marketing Ltd.
Burnham Lane
Slough, Berkshire
SL1 6LN
(44) 628 64422

Yugoslavia

Elektroteh na
Do Junel U.Sol.O.
Tozd Elzas O.Sol.O.
Titova 81
61001 Ljubljana
(38) 61 347749
(38) 61 347841

HP Components Sales and Service

Alabama
P.O. Box 7700
420 Wynn Dr., N.W.
Huntsville 35805
Tel: (205) 830-2000

Arizona
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Phoenix 85044
Tel: (602) 273-8000

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1421 So. Manhattan Ave.
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P.O. Box 23333
San Diego 92123
Tel: (714) 279-3200

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Tel: (408) 988-7000

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Tel: (805) 373-7000

Colorado
24 Inverness Place East
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Tel: (303) 649-5000

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P.O. Box 5007
Wallingford 06492
Tel: (203) 265-7801

Florida
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6177 Lake Ellenor Dr.
Orlando 32809
Tel: (305) 859-2900

Georgia
P.O. Box 105005
2000 South Park Place
Atlanta 30348
Tel: (404) 955-1500

Illinois
5201 Tollview Dr.
Rolling Meadows 60008
Tel: (312) 255-9800

Indiana
11911 No. Meridian Street
Carmel 46032
Tel: (317) 844-4100

Maryland
3701 Koppers St.
Baltimore 21227
Tel: (301) 644-5800

Massachusetts
1775 Minuteman Rd.
Andover 01810
Tel: (617) 682-1500

Michigan
39550 Orchard Hill Place Dr.
Novi 48050
Tel: (313) 349-9200

Minnesota
2025 W. Larpenteur Ave.
St. Paul 55113
Tel: (612) 644-1100

Missouri
1001 East 101 Terr.
Suite 120
P.O. Box 24796
Kansas City 64131
Tel: (816) 941-0411

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Piscataway 08854
Tel: (201) 981-1199

W. 120 Century Rd.
Paramus 07652
Tel: (201) 265-5000

New Mexico
7801 Jefferson St., NE
Albuquerque 87109
Tel: (505) 823-6100

New York
7641 Henry Clay Blvd.
Liverpool 13088
Tel: (315) 451-1820

200 Cross Keys Office
Fairport 14450
Tel: (716) 223-9950

3 Crossways Park West
Woodbury 11797
Tel: (516) 921-0300

North Carolina
305 Gregson Dr.
Cary 27511
Tel: (919) 467-6600

Ohio
15885 Sprague Rd.
Cleveland 44136
Tel: (216) 243-7300

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Miamisburg 45342
(513) 433-2223

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Westerville 43081
Tel: (614) 891-3344

Oregon
9255 S.W. Pioneer Ct.
P.O. Box 328
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Tel: (503) 682-8000

Pennsylvania
2750 Monroe Blvd.
P.O. Box 713
Valley Forge 19482
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Texas
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Austin 78758
Tel: (512) 835-6771

930 E. Campbell Rd.
P.O. Box 831270
Richardson 75083-1270
Tel: (214) 231-6101

Washington
Bellefield Office Pk.
15815 S.E. 37th St.
Bellevue 98006
Tel: (206) 643-4000

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Tel: 35515,35516
E,P

ARGENTINA
Hewlett-Packard Argentina S.A.
Montaneses 2140150
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Tel: 783-4886/4836/4730
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A

AUSTRALIA

Adelaide, South Australia Office
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153 Greenhill Road
PARKSIDE, S.A. 5063
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Brisbane, Queensland Office
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Sydney, New South Wales Office
Hewlett-Packard Australia Ltd.
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Tel: 888-4444
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AUSTRIA
Hewlett-Packard Ges.m.b.h.
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Tel: 295-1816
Telex: 380 3589/ACT BA
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BOLIVIA
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Av. 20 de Octubre #2125
Casilla 1383
LA PAZ
Tel: 368541
A

BRAZIL
\+ Hewlett-Packard do Brasil I.e.C. Ltda.
Alameda Rio Negro, 750
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06400 Barueri SP
Tel.: (011) 421.1311
Telex: (011) 33872 HPBR-BR
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Hewlett Packard do Brasil I.e C.Ltda.
Praia de Botafogo 228-
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458 Todos Os Santos
CEP 20771
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Telex: 33487 EGLB BR
A

ANAMED I.C.E.I. Ltda.
Rua Bage, 103
04012 **SAO PAULO**, *SP*
Tel: (011) 572.6537
Telex: 24740
M

CANADA

Alberta
Hewlett-Packard (Canada) Ltd.
3030 3rd Avenue N.E.
CALGARY, Alberta
T2A 6T7
Tel: (403) 235-3100
A,CH,CM,E,M,P

Hewlett-Packard (Canada) Ltd.
11120-178th Street
EDMONTON, Alberta
T5S 1P2
Tel: (403) 486-6666
A,CH,CM,CS,E,M,P

British Columbia
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10691 Shellbridge Way
RICHMOND,
British Columbia
V6X 2W7
Tel: (604) 270-2277
A,CH,CM,CS,E,M,P

Hewlett-Packard (Canada) Ltd.
121 - 3350 Douglas Street
VICTORIA, British Columbia
V8Z-3L1
Tel: (604) 381-6616
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Hewlett-Packard (Canada) Ltd.
1825 Inkster Blvd.
WINNIPEG, Manitoba
R2X 1R3
Tel: (204) 694-2777
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Hewlett-Packard (Canada) Ltd.
37 Shediac Road
MONCTON, New Brunswick
E1A 2R6
Tel: (506) 855-2841
CH,CS

Nova Scotia
Hewlett-Packard (Canada) Ltd.
900 Windmill Road
DARTMOUTH, Nova Scotia
B3B 1L2
Tel: (902) 469-7820
CH,CM,CS,E,M,P

Ontario
Hewlett-Packard (Canada) Ltd.
3325 N. Service Rd., Unit #3
BURLINGTON, Ontario
L7N 3G2
Tel: (416) 335-8644
CH,M

Hewlet:t-Packard (Canada) Ltd.
496 Days Road
KINGSTON, Ontario
K7M 5R4
Tel: (613) 384-2088
CH,CS

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N6E 2S5
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\+ Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
MISSISSAUGA, Ontario
L4V 1M8
Tel: (416) 678-9430
Telex: 069-8644
A,CH,CM,CS,E,M,P

CANADA (Cont'd)

Hewlett-Packard (Canada) Ltd.
2670 Queensview Dr.
OTTAWA, Ontario
K2B 8K1
Tel: (613) 820-6483
A,CH,CM,CS,E,M,P

Hewlett-Packard (Canada) Ltd.
The Oaks Place, Unit 9
2140 Regent Street
SUDBURY, Ontario
P3E 5S8
Tel: (705) 522-0202
CH

Hewlett-Packard (Canada) Ltd.
3790 Victoria Park Avenue
WILLOWDALE, Ontario
M2H 3H7
Tel: (416) 499-2550
CH,E

Quebec

Hewlett-Packard (Canada) Ltd.
17500 Trans-Canada Highway
South Service Road
KIRKLAND, Quebec
H9J 2X8
Tel: (514) 697-4232
Telex: 058-21521
A,CH,CM,CS,E,M,P

Hewlett-Packard (Canada) Ltd.
1150, rue Claire Fontaine
QUEBEC CITY, Quebec
G1R 5G4
Tel: (418) 648-0726
CH, CS

Hewlett-Packard (Canada) Ltd.
#7-130 Robin Crescent
SASKATOON, Saskatchewan
S7L 6M7
Tel: (306) 242-3702
CH,CS

CHILE

ASC Ltda.
Austrie 2041
SANTIAGO
Tel: 223-5946, 223-6148
Telex: 340192 ASC CK
P,C

Isical Ltda.
Av. Italia 634 Santiago
Casilla 16475
SANTIAGO *9*
Tel: 222-0222
Telex: 440283 JCYCL CZ
CM,E,M

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Monjitas 454 of. 206
SANTIAGO
Tel: 395752, 398296
Telex: 340866 METLAB CK
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Olympia (Chile) Ltda.
Av. Rodrigo de Araya
Casilla 256-V
SANTIAGO
Tel: 225-5044
Telex: 340892 OLYMP
Cable: Olympiachile Santiagochile

CHINA, People's Republic of

China Hewlett-Packard Ltd.
P.O. Box 9610, Beijing
4th Floor, 2nd Watch Factory Main Bldg.
Shuang Yu Shu, Bei San Huan Road
Hai Dian District
BEIJING
Tel: 28-0567
Telex: 22601 CTSHP CN
Cable: 1920 Beijing
A,CH,CM,CS,E,P,M

China-Hewlett-Packard Co. Ltd.
China Resources Building, 47/F
26 Harbour Road, Wanchai
HONG KONG
Tel: 5-8330833
Telex: 76793 HEWPA HX
A,C,CH,CS,E,M,P

CHINA (Cont'd)

China Hewlett-Packard Rep. Office
P.O. Box 418
1A Lane 2, Luchang St.
Beiwei Rd., Xuanwu District
BEIJING
Tel: 33-5950
Telex: 22601 CTSHP CN
Cable: 1920
A,CH,CM,CS,E,M,P

COLOMBIA

Instrumentacion
H.A. Langebeek & Kier S.A.
Carrerra 4a, A No. 52 A 26
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Cable 123 No. 98-31
Apartado Aereo 100-958
BOGOTA *D.E., 10*
Tel: 213-5267, 213-1615
Telex: 43415 HEGAS CO
A

Compumundo
Avenida 15 # 107-80
BOGOTA *D.E.*
Tel: 214-4458
Telex: 45466 MARCO
P

Carvajal S.A.
Calle 29 Norte No. 6A-40
Apartado Aereo 46 **CALI**
Tel: 3681111
Telex: 55650

COSTA RICA

Cientifica Costarricense S.A.
Avenida 2, Calle 5
San Pedro de Montes de Oca
Apartado 10159
SAN JOSE
Tel: 24-38-20, 24-08-19
Telex: 2367 GALGUR CR
CM,E,M

CYPRUS

Telerexa Ltd.
P.O. Box 4809
14C Stassinos Avenue
NICOSIA
Tel: 62698
Telex: 2894 LEVIDO CY
E,M,P

DENMARK

+ Hewlett-Packard A/S
Datavej 52
DK-3460 **BIRKEROD**
Tel: (02) 81-66-40
Telex: 37409 hpas dk
A,CH,CM,CS,E,M,P

Hewlett-Packard Iceland
Hoefdabakka 9
110 Reykjavik
Tel: (1) 67 1000
A,CH,CM,CS,E,M,P

Hewlett-Packard A/S
Rolighedsvej 32
DK-8240 **RISSKOV,** Aarhus
Tel: (06) 17-60-00
Telex: 37409 hpas dk
CH,E

DOMINICAN REPUBLIC

Microprog S.A.
Juan Tomas Mejia y Cotes No. 60
Arroyo Hondo
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Telex: 4510 ARENTA DR (RCA) P

ECUADOR

CYEDE Cia. Ltda
Avenida Eloy Alfaro 1749
y Belgica
Casilla 6423 CCI
QUITO
Tel: 450-975, 243-052
Telex: 22548 CYEDE ED
P,E

Ecuador Overseas Agencies C.A.
Calle 9 de Octubre #818
P.O. Box 1296
GUAYAQUIL
Tel: 306022
Telex: 3361 PBCGYE ED
M

Hospitalar S.A.
Robles 625
Casilla 3590
QUITO
Tel: 545-250, 545-122
Telex: 2485 HOSPTL ED
Cable: HOSPITALAR-Quito
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Meditronics
Valladolid 524 Madrid
P.O. box 9171
QUITO
Tel: 2-238-951
Telex: 2298 ECUAME ED
A

EGYPT

Sakrco Enterprises
P.O. Box 259
ALEXANDRIA
Tel: 802908,808020, 805302
Telex: 54333

Egyptian International
Office for Foreign Trade
P.O. Box 2558
42 El-Zahraa Street
Dokki, **CAIRO,**
Tel: 712230
Telex: 93337 EGPOR UN
Cable: EGYPOR
P,A

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Kasr-el-Aini
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Tel: 23829, 21641
Telex: 93830 IEA UN
Cable: INTEGASSO
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Taleat Harb Square
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Telex: 93156

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Tel: 803844, 805998, 810263
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29 Avenida Norte 1223
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A,CH,CM,CS,E,P

FINLAND

+ Hewlett-Packard Oy
Piispankalliontie 17
02200 **ESPOO**
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Telex: 121563 HEWPA SF
CH,CM,CS,P

FRANCE

Hewlett-Packard France
Z.I. Mercure B
Rue Berthelot
F-13763 Les Milles Cedex
AIX-EN-PROVENCE
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Telex: 410770F
A,CH,E,M,P

Hewlett-Packard France
64, rue Marchand Saillant
F-61000 **ALENCON**
Tel: (33) 29 04 42

Hewlett-Packard France
Boite Postale 503
F-25026 **BESANCON**
28 rue de la Republique
F-25000 **BESANCON**
Tel: (81) 83-16-22
Telex: 361157
CH,M

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13, Place Napoleon III
F-29000 **BREST**
Tel: (98) 03-38-35

Hewlett-Packard France
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Telex: 692315F
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Hewlett-Packard France
5, avenue Raymond Chanas
F-38320 **EYBENS** (Grenoble)
Tel: 76 62-67-98
Telex: 980124 HP GRENOB EYBE
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Hewlett-Packard France
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Batiment Ampere 5 etage
Rue de la Commune de Paris
Boite Postale 300
F-93153 **LE BLANC MESNIL**
Tel: (1) 865-44-52
Telex: 211032F
CH,CS,E,M

Hewlett-Packard France
Parc d'Activites Cadera
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F-33700 **MERIGNAC** (Bordeaux)
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CH,E,M

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ZAC de Bois Briand
F-44085 **NANTES** Cedex
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Telex: 711085F

Hewlett-Packard France
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Hewlett-Packard France
124, Boulevard Tourasse
F-64000 **PAU**
Tel: (59) 80 38 02

Hewlett-Packard France
2 Allee de la Bourgonnette
F-35100 **RENNES**
Tel: (99) 51-42-44
Telex: 740912F
CH,CM,E,M,P

FRANCE (Cont'd)

Hewlett-Packard France
98 Avenue de Bretagne
F-76100 **ROUEN**
Tel: (35) 63-57-66
Telex: 770035F
CS

Hewlett-Packard France
4 Rue Thomas Mann
Boite Postale 56
F-67033 **STRASBOURG** Cedex
Tel: (88) 26-36-46
Telex: 890141F
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Hewlett-Packard France
Le Peripole
20 Chemin du Pigeonnier de la C
epiere
F-31083 **TOULOUSE** Cedex
Tel: (61) 40-11-12
Telex: 531639F
A,CH,CS,E,P

Hewlett-Packard France
9, rue Baudin
F-26000 **VALENCE**
Tel: (75) 42 76 16

Hewlett-Packard France
Carolor
ZAC de Bois Briand
F-57640 **VIGY** (Metz)
Tel: (8) 771 20 22
CH

Hewlett-Packard France
Immeuble Pericentre
F-59658 **VILLENEUVE D'ASCQ**
Cedex
Tel: (20) 91-41-25
Telex: 160124F
CH,E,M,P

GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH
Geschaftsstelle Berlin
Keithstrasse 2-4
1000 **BERLIN** 30
Tel: (030) 219904-0
Telex: 183405 hpbln
A,CH,E,M,P

+ Hewlett-Packard GmbH
Zentralbereich Marketing
Herrenberger Strasse 130
7030 **BOBLINGEN**
Tel: (7031) 14-0
Telex: 7265739 hep
A,CH,CM,CS,E,M,P

Hewlett-Packard GmbH
Vertriebszentrum Boblingen
Schickardstrasse 2
7030 **BOBLINGEN**
Postfach 1427
Tel: (7031) 645-0
Telex: 7265743 hep

Hewlett-Packard GmbH
Geschaftsstelle Dortmund
Schleefstr. 28
4600 **DORTMUND** 41
Tel: (0231) 45001-0
Telex: 822858 hepdod

Hewlett-Packard GmbH
Reparaturszentrum Frankfurt
Berner Strasse 117
6000 **FRANKFURT** am Main 60
Tel: (069) 5004-1
Telex: 413249 hpffm
A,CH,CM,CS,E,M,P

Hewlett-Packard GmbH
Vertriebszentrale Deutschland
Hewlett-Packard Strasse
Postfach 1641
6380 **BAD HOMBURG** v.d.H.
Tel: (06172) 400-0
Telex: 410844 hpbhg

Hewlett-Packard GmbH
Vertriebszentrum Nord
Kapstadtring 5
2000 **HAMBURG** 60
Tel: (040) 63804-0
Telex: 2163032 hphh
A,CH,CS,E,M,P

Hewlett-Packard GmbH
Geschaftsstelle Hannover
Heidering 37-39
3000 **HANNOVER** 61
Tel: (0511) 5706-0
Telex: 923259 hphan
A,CH,CM,E,M,P

Hewlett-Packard GmbH
Geschaftsstelle Mannheim
Rosslauer Weg 2-4
6800 **MANNHEIM** 31
Tel: (0621) 7005-0
Telex: 462105 hpmhm
A,C,E

Hewlett-Packard GmbH
Geschaftsstelle Neu Ulm
Messerschmittstrasse 7
7910 **NEU ULM**
Tel: (0731) 7073-0
Telex: 712816 hpulm
A,C,E

Hewlett-Packard GmbH
Geschaftsstelle Nurnberg
Emmericher Strasse 13
8500 **NURNBERG** 10
Tel: (0911) 5205-0
Telex: 623860 hpnbg
CH,CM,E,M,P

Hewlett-Packard GmbH
Vertriebszentrum Ratingen
Berliner Strasse 111
4030 **RATINGEN** 4
Postfach 31 12
Tel: (02102) 494-0
Telex: 589070 hprad

Hewlett-Packard GmbH
Vertriebszentrum Munchen
Eschenstrasse 5
8028 **TAUFKIRCHEN**
Tel: (089) 61207-0
Telex: 524985 hpmch
A,CH,CM,E,M,P

Hewlett-Packard HmbH
Geschaftsstelle Karlsruhe
Ermlisallee
7517 **WALDBRONN** 2
Postfach 1251
Tel: (07243) 602-0
Telex: 782838 hepk

GREAT BRITAIN
(See United Kingdom)

GREECE

+ Hewlett-Packard Hellas
178, Kifissias Avenue
6th Floor
Halandri-**ATHENS**
Greece
Tel: 6471673, 6471543, 6472971
A,CM,E,M,P

Kostas Karaynnis S.A.
8 Omirou Street
ATHENS *133*
Tel: 32 30 303, 32 37 371
Telex: 215962 RKAR GR
A,CH,CM,CS,E,M,P

PLAISIO S.A.
Eliopoulos Brothers Ltd.
11854 **ATHENS**
Tel: 34-51-911
Telex: 216286
P

GUATEMALA

IPESA
Avenida Reforma 3-48, Zona 9
GUATEMALA CITY
Tel: 316827, 314786
Telex: 4192 TELTRO GU
A,CH,CM,CS,E,M,P

HONG KONG

+ Hewlett-Packard Hong Kong, Ltd.
G.P.O. Box 795
5th Floor, Sun Hung Kai Centre
30 Harbour Road, **HONG KONG**
Tel: 5-8323211
Telex: 66678 HEWPA HX
Cable: HEWPACK HONG KONG
E,CH,CS,P

CET Ltd.
10th Floor, Hua Hsia, Bldg.
64-66 Gloucester Road
HONG KONG
Tel: (5) 200922
Telex: 85148 CET HX
CM

Schmidt & Co. (Hong Kong) Ltd.
18th Floor, Great Eagle Centre
23 Harbour Road, Wanchai
HONG KONG
Tel: 5-8330222
Telex: 74766 SCHMC HX
A,M

ICELAND

Elding Trading Company Inc.
Hafnarnvoli-Tryggvagotu
P.O. Box 895
*IS-***REYKJAVIK**
Tel: 1-58-20, 1-63-03
M

INDIA

Blue Star Ltd.
Sabri Complex 2nd Floor, 24 Residency Rd.
BANGALORE *560 025*
Tel: 55660, 578881
Telex: 0845-430
Cable: BLUESTAR
A,CM,E

+ *Blue Star Ltd.*
Band Box House, Prabhadevi
BOMBAY *400 025*
Tel: 4933101 4933222
Telex: 011-71051
Cable: BLUESTAR
A,M

Blue Star Ltd.
Sahas, 414/2 Vir Savarkar Marg
Prabhadevi
BOMBAY *400 025*
Tel: 422-6155, 422-6556
Telex: 011-71193 BSSS IN
Cable: FROSTBLUE
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Blue Star Ltd.
Kalyan, 19 Vishwas Colony
Alkapuri, **BARODA,** *390 005*
Tel: 65235
Cable: BLUE STAR
A

Blue Star Ltd.
7 Hare Street
CALCUTTA *700 001*
Tel: 230131, 230132
Telex: 021-7655
Cable: BLUESTAR
A,M

Blue Star Ltd.
133 Kodambakkam High Road
MADRAS *600 034*
Tel: 472056, 470238
Telex: 041-379
Cable: BLUESTAR
A,M

Blue Star Ltd.
13, Community Center
New Friends Colony
NEW DELHI *110 065*
Tel: 633773
Telex: 031-61120
Cable: BLUEFROST
A,CM,E,M

Blue Star Ltd.
15/16 C Wellesley Rd.
PUNE *411 011*
Tel: 22775
Cable: BLUE STAR
A

Blue Star Ltd.
2-2-47/1108 Bolarum Rd.
SECUNDERABAD *500 003*
Tel: 72057
Telex: 0155-645
Cable: BLUESTAR
A,E

Blue Star Ltd.
T.C. 7/603 Poornima, Maruthankuzhi
TRIVANDRUM *695 013*
Tel: 65799
Telex: 0884-259
Cable: BLUESTAR
E

INDONESIA

BERCA Indonesia P.T.
P.O. Box 496/Jkt.
Jl. Abdul Muis 62, **JAKARTA**
Tel: 21-373009
Telex: 46748 BERSAL IA
Cable: BERSAL JAKARTA
P

BERCA Indonesia P.T.
P.O. Box 2497/Jkt.
Antara Bldg., 12th Floor
Jl. Medan Merdeka Selatan 17
JAKARTA-PUSAT
Tel: 340417, 341445
Telex: 46748 BERSAL IA
A,CS,E,M

BERCA Indonesia P.T.
Jl. Kutai no. 24, **SURABAYA**
Tel: (031) 67118
Telex: 31146 BERSAL SB
Cable: BERSAL-SURABAYA
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IRAQ

Hewlett-Packard Trading S.A.
Service Operation
Al Mansoor City 9B/3/7
BAGHDAD
Tel: 551-49-73
Telex: 212-455 HEPAIRAQ IK
CH,CS

IRELAND

Hewlett-Packard Ireland Ltd.
82/83 Lower Leeson Street
DUBLIN 2
Tel: 0001 608800
Telex: 30439
CH,CS,E,P

Cardiac Services Ltd.
Kilmore Road
Artane
DUBLIN *5*
Tel: (01) 351820
Telex: 30439
M

ISRAEL

Eldan Electronic Instrument Ltd.
P.O. Box 1270
JERUSALEM *91000*
16, Ohaliav St.
JERUSALEM *94467*
Tel: 533 221, 553 242
Telex: 25231 AB/PAKRD IL
A,M

Computation and Measurement Systems (CMS) Ltd.
11 Masad Street
67060 **TEL-AVIV**
Tel: 388 388
Telex: 33569 Motil IL
CM,CH,CS,E,P

ITALY

Hewlett-Packard Italiana S.p.A.
Traversa 99C
Via Giulio Petroni, 19
I-70124 **BARI**
Tel: (080) 41-07-44
CH,M,

Hewlett-Packard Italiana S.p.A.
Via Martin Luther King, 38/III
I-40132 **BOLOGNA**
Tel: (051) 402394
Telex: 511630
CH,CS,E,M

Hewlett-Packard Italiana S.p.A.
Via Principe Nicola 43G/C
I-95126 **CATANIA**
Tel: (095) 37-10-87
Telex: 970291
CH

+ Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio 9
I-20063 **CERNUSCO SUL NAVIGLIO**
(Milano)
Tel: (02) 923691
Telex: 334632
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ITALY (Cont'd)

Hewlett-Packard Italiana S.p.A.
Via C. Colombo 49
I-20090 **TREZZANO SUL NAVIGLIO**
(Milano)
Tel: (02) 4459041
Telex: 322116
CH,CS

Hewlett-Packard Italiana S.p.A.
Via Nuova San Rocco a Capodimonte, 62/A
I-80131 **NAPOLI**
Tel: (081) 7413544
Telex: 710698
CH,CS,E,M

Hewlett-Packard Italiana S.p.A.
Viale G. Modugno 33
I-16156 **GENOVA PEGLI**
Tel: (010) 68-37-07
Telex: 215238
E,C

Hewlett-Packard Italiana S.p.A.
Via Pelizzo 15
I-35128 **PADOVA**
Tel: (049) 664888
Telex: 430315
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Hewlett-Packard Italiana S.p.A.
Viale C. Pavese 340
I-00144 **ROMA EUR**
Tel: (06) 54831
Telex: 610514
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Hewlett-Packard Italiana S.p.A.
Via di Casellina 57/C
I-50018 **SCANDICCI-FIRENZE**
Tel: (055) 753863
CH,E,M,

Hewlett-Packard Italiana S.p.A.
Corso Svizzera, 185
I-10144 **TORINO**
Tel: (011) 74 4044
Telex: 221079
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JAPAN

Yokogawa-Hewlett-Packard Ltd.
152-1, Onna
ATSUGI, Kanagawa, 243
Tel: (0462) 25-0031
CM,C,E

Yokogawa-Hewlett-Packard Ltd.
Meiji-Seimei Bldg. 6F
3-1 Hon Chiba-Cho
CHIBA, 280
Tel: (0472) 25 7701
E,CH,CS

Yokogawa-Hewlett-Packard Ltd.
Yasuda-Seimei Hiroshima Bldg.
6-11, Hon-dori, Naka-ku
HIROSHIMA, 730
Tel: (082) 241-0611

Yokogawa-Hewlett-Packard Ltd.
Towa Building
2-3, Kaigan-dori, 2 Chome Chuo-ku
KOBE, 650
Tel: (078) 392-4791
C,E

Yokogawa-Hewlett-Packard Ltd.
Kumagaya Asahi 82 Bldg.
3-4 Tsukuba
KUMAGAYA, Saitama 360
Tel: (0485) 24-6563
CH,CM,E

Yokogawa-Hewlett-Packard Ltd.
Asahi Shinbun Daiichi Seimei Bldg.
4-7, Hanabata-cho
KUMAMOTO, 860
Tel: (0963) 54-7311
CH,E

Yokogawa-Hewlett-Packard Ltd.
Shin-Kyoto Center Bldg.
614, Higashi-Shiokoji-cho
Karasuma-Nishiiru
Shiokoji-dori, Shimogyo-ku
KYOTO, 600
Tel: 075-343-0921
CH,E

Yokogawa-Hewlett-Packard Ltd.
Mito Mitsui Bldg.
4-73, Sanno-maru, 1 Chome
MITO, Ibaraki 310
Tel: (0292) 25-7470
CH,CM,E

Yokogawa-Hewlett-Packard Ltd.
Meiji-Seimei Kokubun Bldg. 7-8
Kokubun, 1 Chome, Sendai
MIYAGI, 980
Tel: (0222) 25-1011
C,E

Yokogawa-Hewlett-Packard Ltd.
Nagoya Kokusai Center Bldg.
47-1 Nagono 1 Chome
Nakamura-ku
NAGOYA, 450
Tel: (052) 571-5171
CH,CM,CS,E,M

Yokogawa-Hewlett-Packard Ltd.
Chuo Bldg.
4-20 Nishinakajima, 5 Chome
Yodogawa-ku
OSAKA, 532
Tel: (06) 304-6021
Telex: YHPOSA 523-3624
A,CH,CM,CS,E,M,P

Yokogawa-Hewlett-Packard Ltd.
27-15, Yabe, 1 Chome
SAGAMIHARA Kanagawa, 229
Tel: 0427 59-1311

Yokogawa-Hewlett-Packard Ltd.
Daiichi Seimei Bldg.
7-1, Nishi Shinjuku, 2 Chome
Shinjuku-ku, **TOKYO** 160
Tel: 03-348-4611
CH,E,M

Yokogawa Hewlett-Packard Ltd.
9-1, Takakura-cho
Hachioji-shi, **TOKYO,** 192
Tel: 0426-42-1261
CH,E

+ Yokogawa-Hewlett-Packard Ltd.
29-21 Takaido-Higashi, 3 Chome
Suginami-ku **TOKYO** 168
Tel: (03) 331-6111
Telex: 232-2024 YHPTOK
A,CH,CM,CS,E,P

Yokogawa-Hewlett-Packard Ltd.
Meiji-Seimei Utsunomiya Oodori Bldg.
1-5 Oodori, 2 Chome
UTSUNOMIYA, Tochigi 320
Tel: (0286) 34-1175
CH,CS,E

Yokogawa-Hewlett-Packard Ltd.
Yasuda Seimei Nishiguchi Bldg.
30-4 Tsuruya-cho, 3 Chome
YOKOHAMA 221
Tel: (045) 312-1252
CH,CM,E

JORDAN

Scientific and Medical Supplies Co.
P.O. Box 1387
AMMAN
Tel: 24907, 39907
Telex: 21456 SABCO JO
CH,E,M,P

KENYA

ADCOM Ltd., Inc., Kenya
P.O. Box 30070
NAIROBI
Tel: 331955
Telex: 22639
E,M

KOREA

Samsung Hewlett-Packard Co. Ltd.
Dongband Yeoeuido Bldg.
12-16th Floors
36-1 Yeoeuido-Dong
Youngdeungpo-ku
SEOUL
Tel: 784-4666, 784-2666
Telex: 25166 SAMSAN K
A,CH,CM,CS,E,M,P

Dongbang Healthcare Products Co. Ltd.
Suite 301 Medical Supply Center
Bldg. 1-31 Dongsungdong
Jong Ro-gu, **SEOUL**
Tel: 764-1171
Telex: K25706 TKBKO
Cable: TKBEEPKO
M

Young-in Scientific Co. Ltd.
Younguha Bldg.
547 Shinsa-Dong
Kangnam-Ku, **SEOUL**
Tel: 546-7771
Telex: K23457 GINSCO
A

KUWAIT

Al Khaldiya Trading & Contracting
P.O. Box 830
SAFAT
Tel: 424910, 411726
Telex: 22481 AREEG KT
Cable: VISCOUNT
E,M,A

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P.O. Box 270
SAFAT
Tel: 2445111
Telex: 22247 MATIN KT
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P.O. Box 5897
SAFAT
Tel: 2462640/1
Telex: 30336 TOWELL KT
C

LEBANON

Computer Information Systems
P.O. Box 11-6274
BEIRUT
Tel: 89 40 73
Telex: 42309
C,E,M,P

LUXEMBOURG

Hewlett-Packard Belgium S.A./N.V.
Blvd. de la Woluwe, 100
Woluwedal
B-1200 **BRUSSELS**
Tel: (02) 762-32-00
Telex: 23-494 paloben bru
A,CH,CM,CS,E,M,P

MALAYSIA

Hewlett-Packard Sales (Malaysia) Sdn.Bhd.
9th Floor, Chung Khiaw Bank Building
46 Jln Raja Laut
KUALA LUMPUR
Tel: 986555
Telex: HPSM MA 31011
A,CH,E,M,P

Protel Engineering
P.O. Box 1917
Lot 6624, Section 64
23/4 Pending Road
Kuching, **SARAWAK**
Tel: 36299
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MALTA

Philip Toledo Ltd.
P.O. Box LL
Notabile Rd.
MRIEHEL
Tel: 447 47, 455 66, 4915 25
Telex: Media MW 649
E,P,M

MEXICO

+ Hewlett-Packard de Mexico, S.A. de C.V.
Av. Periferico Sur No. 6501
Tepepan, Xochimilco
16020 **MEXICO D.F.**
Tel: 6-76-46-00
Telex: 17-74-507 HEWPACK MEX
A,CH,CS,E,M,P

Hewlett-Packard de Mexico, S.A. de C.V.
Czda.del Valle
409 Ote. — 4th Piso
Colonia del Valle
Municipio de Garza Garcia Nuevo Leon
66220 **MONTERREY**
Tel: 78 42 41
Telex: 038 410
CH

Hewlett-Packard de Mexico, S.A.
Francisco J. Allen #30
Colonia Nueva
Los Angeles 27140
COAHUILA, Torreon
Tel: 37220

Microcomputadoras Hewlett-Packard S.A.
Monte 115 Pelvoux de C.V.
Mexico, D.F. **LOS LOMAS**
Tel: 520-9127

Equipos Cientificos de Occidente, S.A.
Av. Lazaro Cardenas 3540
GUADALAJARA
Tel: 21-66-91
Telex: 0684 186 ECOME
A

Infograficas y Sistemas del Noreste, S.A.
Rio Orinoco #171 Oriente
Despacho 2001
Colonia Del Valle
MONTERREY
Tel: 782499, 781259
A,E

Hewlett-Packard de Mexico (Polanco)
Avenida Ejercito Nacional #579
2do y 3er Piso
COLONIA GRANADA 11520
Mexico, D.F.
Tel: 211-3683

MOROCCO

Dolbeau
81 rue Karatchi
CASABLANCA
Tel: 3041-82, 3068-38
Telex: 23051, 22822
E

Gerep
2 rue d'Agadir
Boite Postale 156
CASABLANCA
Tel: 272093, 272095
Telex: 23 739
P

Sema-Maroc
Rue Lapebie
CASABLANCA
Tel: 26.09.80
CH,CS,P

NETHERLANDS

Hewlett-Packard Nederland B.V.
Startbaan 16
1187 XR Amstelveen
P.O. Box 667
NL-1180 AR **AMSTELVEEN**
Tel: (20) 547 6911
Telex: 13216 hepa nl
A,CH,CM,CS,E,P

Hewlett-Packard Nederland B.V.
Bongerd 2
NL 2906VK **CAPELLE A/D IJSSEL**
P.O. Box 41
NL 2900AA **CAPELLE A/D IJSSEL**
Tel: (10) 51-64-44
Telex: 21261 HEPAC NL
A,CH,CS,E

Hewlett-Packard Nederland B.V.
Pastoor Petersstraat 134-136
NL 5612 LV **EINDHOVEN**
P.O. Box 2342
NL 5600 CH **EINDHOVEN**
Tel: (040) 326911
Telex: 51484 hepae nl
A,E,M

NEW ZEALAND

Hewlett-Packard (N.Z.) Ltd.
5 Owens Road
P.O. Box 26-189
Epsom, **AUCKLAND**
Tel: 687-159
Cable: HEWPAK Auckland
CH,CS,CM,E,P

+ Hewlett-Packard (N.Z.) Ltd.
4-12 Cruickshank Street
Kilbirnie, **WELLINGTON 3**
P.O. Box 9443
Courtenay Place, **WELLINGTON 3**
Tel: 877-199
Cable: HEWPACK Wellington
CH,CS,CM,E,P

Northrop Instruments & Systems Ltd.
369 Khyber Pass Road
P.O. Box 8602
AUCKLAND
Tel: 794-091
Telex: 60605
A,M

NEW ZEALAND (Cont'd)

Northrop Instruments & Systems Ltd.
110 Mandeville St.
P.O. Box 8388
CHRISTCHURCH
Tel: 488-873
Telex: 4203
A,M

Northrop Instruments & Systems Ltd.
Sturdee House
85-87 Ghuznee Street
P.O. Box 2406
WELLINGTON
Tel: 850-091
Telex: NZ 3380
A,M

NORWAY

Hewlett-Packard Norge A/S
Folke Bernadottes vei 50
P.O. Box 3558
N-5033 **FYLLINGSDALEN** (Bergen)
Tel: 0047/5/16 55 40
Telex: 76621 hpnas n
CH,CS,E,M

+ Hewlett-Packard Norge A/S
Osterndalen 16-18
P.O. Box 34
N-1345 **OSTERAS**
Tel: 0047/2/17 11 80
Telex: 76621 hpnas n
A,CH,CM,CS,E,M,P

OMAN

Khimjil Ramdas
P.O. Box 19
MUSCAT
Tel: 722225, 745601
Telex: 5289 BROKER MB MUSCAT
P

Suhail & Saud Bahwan
P.O. Box 169
MUSCAT
Tel: 734 201-3
Telex: 5274 BAHWAN MB
E

Imtac LLC
P.O. Box 8676
MUTRAH
Tel: 601695
Telex: 5741 Tawoos On
A,C,M

PAKISTAN

Mushko & Company Ltd.
House No. 16, Street No. 16
Sector F-6/3
ISLAMABAD
Tel: 824545
Telex: 54001 MUSKI PK
Cable: FEMUS Islamabad
A,E,P

Mushko & Company Ltd.
Oosman Chambers
Abdullah Haroon Road
KARACHI *0302*
Tel: 524131, 524132
Telex: 2894 MUSKO PK
Cable: COOPERATOR Karachi
A,E,P

PANAMA

Electronico Balboa, S.A.
Calle Samuel Lewis, Ed. Alfa
Apartado 4929

PANAMA 5
Tel: 642700
Telex: 3483 ELECTRON PG
A,CM,E,M,P

PERU

Cia Electro Medica S.A.
Los Flamencos 145, San Isidro
Casilla 1030
LIMA *1*
Tel: 41-4325, 41-37015
Telex: Pub. Booth 25306 PEC PISIDR
CM,E,M,P

SAMS S.A.
Avenida Republica de Panama 3534
SAN ISIDRO, *Lima*
Tel: 419928/417108
Telex: 20450 PE LIBERTAD

PHILIPPINES

The Online Advanced Systems Corporation
2/F Electra House
Esteban Street
Legaspi Village
Makati
Metro **MANILA**
Tel: 815-38-11 (up to 16)
Telex: 63274 Online PN
A,CH,CS,E,M,P

PORTUGAL

Mundinter
Intercambio Mundial de Comercio S.A.R.L.
P.O. Box 2761
Av. Antonio Augusto de Aguiar 138
*P-***LISBON**
Tel: (19) 53-21-31, 53-21-37
Telex: 16691 munter p
M

Soquimica
Av. da Liberdade, 220-2
1298 **LISBON** *Codex*
Tel: 56 21 81/2/3
Telex: 13316 SABASA
P

Telectra-Empresa Tecnica de Equipmentos Electricos S.A.R.L.
Rua Rodrigo da Fonseca 103
P.O. Box 2531
*P-***LISBON** *1*
Tel: (19) 68-60-72
Telex: 12598
CM,E

Rarcentro Ltda
R. Costa Cabral 575
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Modern Electronic Establishment
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AL-KHOBAR
Tel: 895-1760, 895-1764
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Modern Electronic Establishment
Hewlett-Packard Division
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Redec Plaza, 6th Floor
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Tel: 40 41 717
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Pte. Ltd.
#08-00 Inchcape House
450-2 Alexandra Road
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Telex: 6-22954
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GREAT BRITAIN

Hewlett-Packard Ltd.
Trafalgar House
Navigation Road
ALTRINCHAM
Cheshire WA14 1NU
Tel: 061 928 6422
Telex: 668068
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+ Hewlett-Packard Ltd.
Miller House
The Ring, **BRACKNELL**
Berks RG12 1XN
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Telex: 848733
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Elstree House, Elstree Way
BOREHAMWOOD, Herts WD6 1SG
Tel: 01 207 5000
Telex: 8952716
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Oakfield House, Oakfield Grove
Clifton **BRISTOL,** Avon BS8 2BN
Tel: 0272 736806
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Bridewell House
Bridewell Place
LONDON EC4V 6BS
Tel: 01 583 6565
Telex: 298163
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Hewlett-Packard Ltd.
Harman House
1 George Street
Uxbridge,
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Telex: 893134/5
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Hewlett-Packard Ltd.
Pontefract Road
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WF6 1RN
Tel: 0924 895566
Telex: 557355
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The Quadrangle
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REDHILL, Surrey RH1 1PS
Tel: 0737 68655
Telex: 947234
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Avon House
435 Stratford Road
Shirley, **SOLIHULL,** West Midlands
B90 4BL
Tel: 021 745 8800
Telex: 339105
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Hewlett-Packard Ltd.
West End House
41 High Street, West End
SOUTHAMPTON
Hampshire SO3 3DQ
Tel: (0703) 476767
Telex: 477138
CH,CS

Hewlett-Packard Ltd.
King Street Lane
Winnersh, **WOKINGHAM**
Berkshire RG11 5AR
Tel: 0734 784774
Telex: 847178
CH,CS,E,

Hewlett-Packard Ltd.,
Customer Support Centre
Eskdale Road,
Winnersh, **WOKINGHAM**
Berkshire, RG115D2
Tel: (0734) 696622
Telex: 848884
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SCOTLAND

Hewlett-Packard Ltd.,
15 Carden Place,
ABERDEEN
AB1 1UR
Tel: 0224 638042
E,CH

Hewlett-Packard Ltd.
SOUTH QUEENSFERRY
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Telex: 72682/3
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URUGUAY

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Apartado 2646
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Cable: HEWPACKSA Athens

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7, Rue du Bois-du-Lan
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Cable: HEWPACKSA Geneve

ASIA
Hewlett-Packard Asia Ltd.
47/F, China Resources Bldg.
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G.P.O. Box 863,
Tel: 5-8330833
Telex: 76793 HPA HX
Cable: HPASIALTD TD

EASTERN EUROPE
Hewlett-Packard Ges.m.b.h.
Lieblgasse 1
P.O. Box 72
A-1222 **VIENNA**, Austria
Tel: (222) 2365110
Telex: 1 3 4425 HEPA A

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Uilenstede 475
P.O. Box 999
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The Netherlands
Tel: 20 437771

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World Trade Center
110 Avenue Louis Casal
1215 Cointrin, **GENEVA**
Switzerland
Tel: (022) 98 96 51
Telex: 27225 hpser

OTHER INTERNATIONAL AREAS
Hewlett-Packard Co.
Intercontinental Headquarters
3495 Deer Creek Road
PALO ALTO, CA 94304
Tel: (415) 857-1501
Telex: 034-8300
Cable: HEWPACK

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